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Instructions: W001/053

Product:
Part no.: 0 001 6..

Continue: I01/2

Table of contents

Continue: I01/1

SPECIAL FEATURES

These instructions describe repair procedures for the following types of sliding-gear starter:

- 0 001 601 ...	TB 24 V/15 kW
- 0 001 602 002	TE 24 V/10 kW
- 0 001 603 ...	TE 24 V/15 kW
- 0 001 608 003	TF 24 V/15 kW
- 0 001 608 005	TF 24 V/15 kW
- 0 001 613 ...	TF 24 V/18 kW
- 0 001 615 ...	TB 24 V/18 kW

Continued on next page.

Continue: I02/2

SPECIAL FEATURES

- 0 001 601 ...	TB 32 V/18 kW
	TE 32 V/18 kW
	TF 32 V/18 kW
	TB 36 V/20 kW
	TE 36 V/20 kW
	TF 36 V/20 kW

Continue: I03/1

SPECIAL FEATURES

In terms of T-starter design, a distinction is made between TB, TE and TF-starters.

TE and TF-starters are fitted with a reduction gear.
Apart from this, the design of all starter versions is identical.

The checking of starters with protection against oil and water is described in separate instructions.

Continue: I04/1

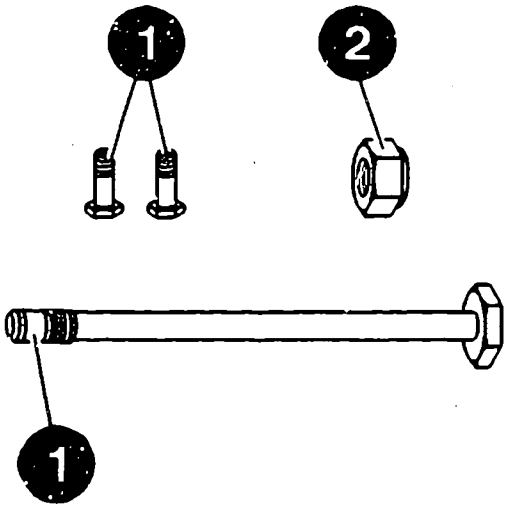
SPECIAL FEATURES

Use is not made on new T-starters of tab or lock washers, but rather of micro-encapsulated bolts and Uni-Stop nuts. Micro-encapsulated bolts and Uni-Stop nuts are designed for once-only use.

1 = An adhesive coating on the thread renders micro-encapsulated*) bolts self-locking
2 = Uni-Stop nuts*) are rendered self-locking by means of an integrated slot
*) = Manufacturer's designation

Continue: I05/1 Fig.: I04/2

KMS00571



SPECIAL FEATURES

The following components are required for pinion attachment on starters up to FD 821 (Jan. 78):

- Lock washer: 1 000 146 001
- Uni-Stop nut (depending on thread)
  - M 10: 2 003 315 002
  - M 10 x 1: 2 003 315 000

On starters as of FD 822 (Feb. 78), the engagement rod and pinion feature a slot for a feather key to prevent turning. The engagement rod always has an M10 thread.

Continue: I05/2

SPECIAL FEATURES

For replacement purposes, the new engagement rod is supplied as a parts set with Uni-Stop nut and feather key.

A new pinion (with feather key slot) is also required when replacing engagement rod on starters up to FD 821 (Jan. 78).

On the other hand, a new pinion (with feather key slot) can also be used for starters with old engagement rod up to FD 821 (Jan. 78).

Continue: I06/1

SPECIAL FEATURES

Starters may be operated with a combined start-inhibit and repeating relay.

This relay replaces the mechanical start repeating relay and the electro-mechanical start-inhibit relay.

The combined start-inhibit and repeating relay is ONLY to be used for individual operation.

Combined start-inhibit and repeating relay for parallel operation on request.

Continue: I06/2

SPECIAL FEATURES

The functions of the combined start-inhibit and repeating relay are as follows:

* Start-inhibit function (shutoff in the event of sustained operation, prevention of starter actuation with engine running and following interruption of start command until engine comes to a stop)

* Start repeating function (automatic repetition of starter actuation until starter pinion has meshed)

Continue: I01/1

GENERAL

Unless otherwise stated, the voltages indicated in these instructions are DC voltages.
AC voltages are marked by the symbol " ≋ ".

Continue: I07/2

GENERAL

Expert repairs are only possible using the prescribed tools and measuring instruments, which are in perfect working order. We therefore recommend that exclusive use be made of the tools listed.

The use of incorrect and unsuitable tools and testers can lead to injury and may damage the product concerned or its component parts.

Continue: I08/1

GENERAL

Only use replacement parts given in the service parts list for the starting motor concerned.

Proper functioning presupposes use of the lubricants specified in these instructions, both prior to and during assembly.

Absolute cleanliness is to be ensured when performing repair work.

Continue: I01/1

SAFETY MEASURES

Component cleaning:
Armature, windings, bushings, relays and the shaft ends of the multi-plate clutch are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agent.

Other components such as bolts, engagement rod, deep-groove ball bearing and drive end shield can be washed out in a commercial cleaning agent which is not readily inflammable. Take care not to inhale vapors.

Continue: I09/2

SAFETY MEASURES

Danger of fire: Take care to avoid naked flames and sparking.

ATTENTION:
Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Always use the listed tools. Injuries cannot be precluded if use is made of incorrect and unsuitable tools and testers.

Continue: I10/1

SAFETY MEASURES

Always heed the following safety regulations:

* German Order governing the use of flammable liquids (VbF).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for the handling of chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: I10/2

SAFETY MEASURES

Outside Germany, pay attention to appropriate local regulations.

Skin protection:
To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

TESTERS, FIXTURES, TOOLS

Listed in the following are all the tools required for repairing type TB, TE and TF starters.

Some of the necessary tools have to be improvised on the basis of the drawings.

The type designation for tools which used to be ordered on this basis is given in parentheses.

Continue: I11/2

TESTERS, FIXTURES, TOOLS

Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 114
Alternator tester WPG 012.00:	0 684 201 200
High-voltage insulation tester:	comm. avail.
Magnetic measurement stand:	4 851 601 124
Dial gauge:	1 687 233 011

Continue: I12/1

TESTERS, FIXTURES, TOOLS

Clamping support:	0 986 619 362 (KDAW 9999)
Pole-shoe screwdriver:	0 986 619 393 (KDAW 9999/7)
Hexagon bit 5/16" - With slot: - With cross head size 4:	 comm. avail. comm. avail.
Torquemeter (33...300 Nm):	0 986 617 166 (KDAL 5476)

Continue: I12/2

TESTERS, FIXTURES, TOOLS

Puller:	0 986 617 233 (KDAL 5492)
Spring collet 18.1 mm:	0 986 617 240 (KDAL 5492/0/7)
Spring collet:	0 986 619 233 (KDAW 9995/6)
Clamping pin for mandrel press tools:	0 986 618 124 (KDLJ 6010)

Continue: I13/1

TESTERS, FIXTURES, TOOLS

Torquemeter (0.15...0.80 Nm):	0 986 617 206 (KDAL 5485)
Spring balance (2...12 N):	0 986 619 181 (KDAW 9991)
Puller:	comm. avail.
Mandrel press:	comm. avail.

Continue: I14/1

TESTERS, FIXTURES, TOOLS

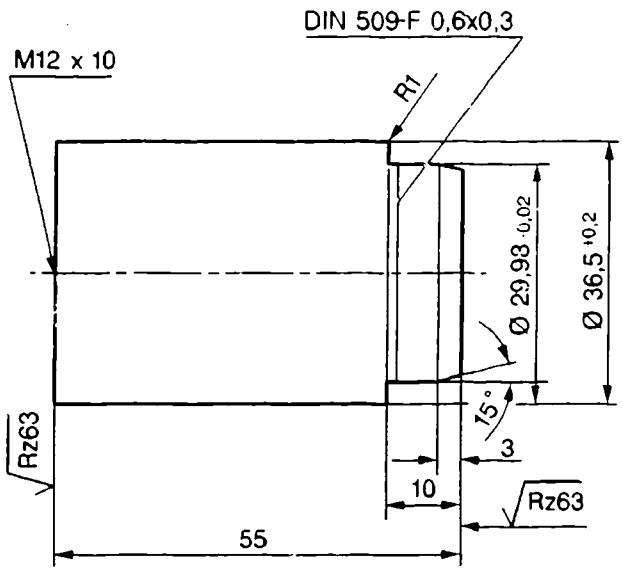
Pressing-out mandrel for bushing in commutator end shield: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: I15/1 Fig.: I14/2

KMS00539



$\sqrt{Rz16}$ ($\sqrt{Rz63}$)

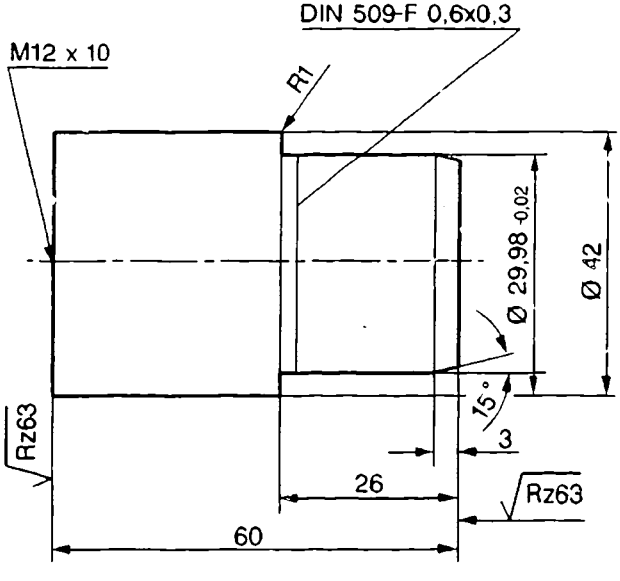
Pressing-in mandrel for
bushing in
commutator end shield: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: I16/1 Fig.: I15/2

KMS00540



$\sqrt{Rz16}$ $\left(\sqrt{Rz63}\right)$

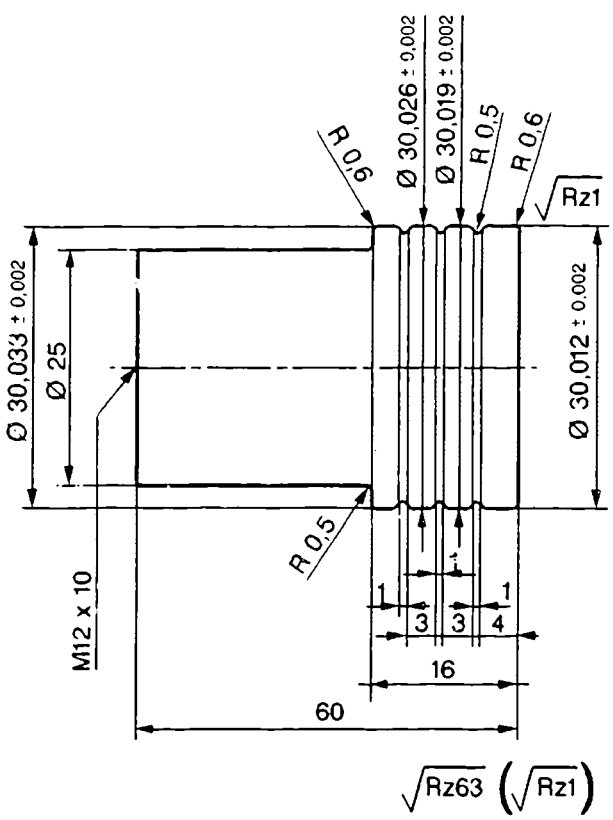
Smoothing mandrel for
bushing in
commutator end shield: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 56...60 HRC

Continue: I17/1 Fig.: I16/2

KMS00541



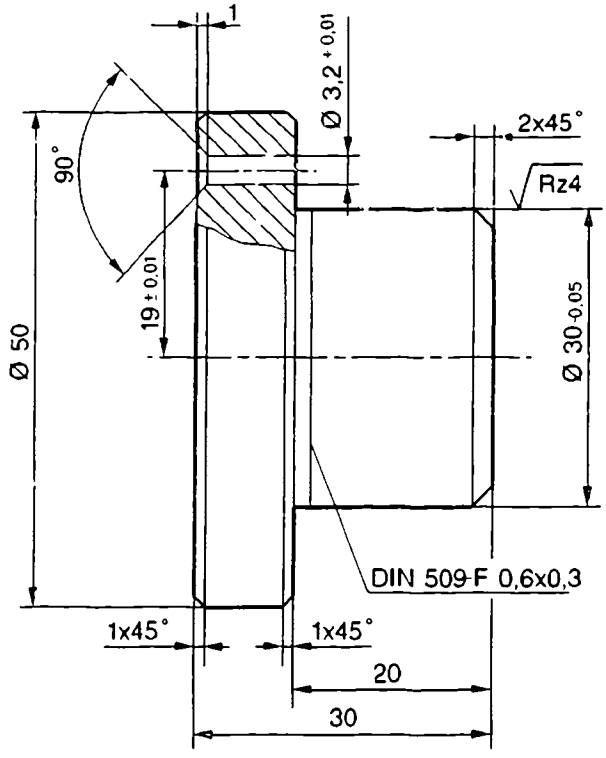
Drill jig for
bushing in
commutator end shield: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 56...60 HRC

Continue: I18/1 Fig.: I17/2

KMS00542



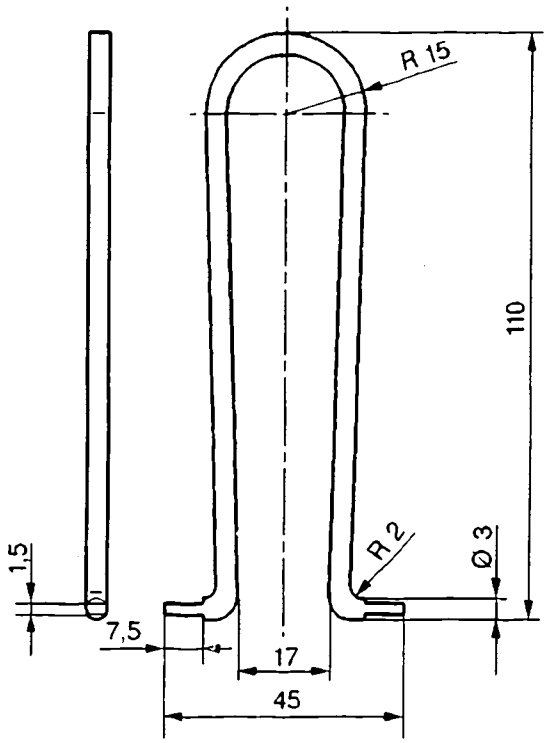
$\sqrt{Rz63}$ ($\sqrt{Rz4}$)

Tool for lifting
spiral compression springs
of carbon brushes: to be improvised

Recommended material: spring steel

Continue: I19/1 Fig.: I18/2

KMS00543



$\sqrt{Rz16}$

TESTERS, FIXTURES, TOOLS

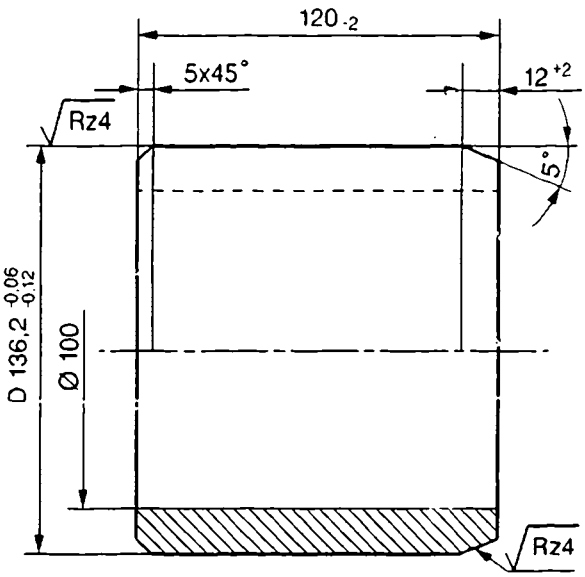
Driving-in mandrel for fitting excitation winding: to be improvised

Recommended material: 1.2842 (90 MnCrV 8)

Recommended heat treatment: Hardened to 56...60 HRC

Continue: I20/1 Fig.: I19/2

KMS00544



$\sqrt{Rz16}$ ($\sqrt{Rz4}$)

TESTERS, FIXTURES, TOOLS

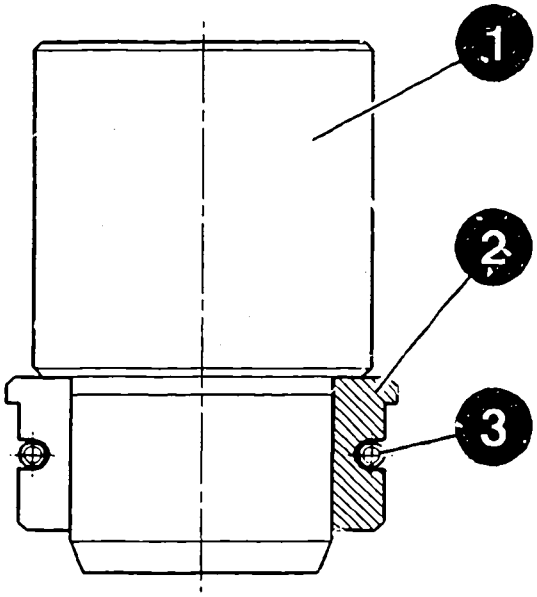
Improvised tool for pressing out cylindrical roller bearing in drive/ reduction gear end shield

General view

1 = Mandrel
2 = Thrust piece (3-part)
3 = Commercially available O-ring
- ID: 32 mm
- OD: 37 mm
- Thickness: 2,5 mm

Continue: I21/1 Fig.: I20/2

KMS00545



TESTERS, FIXTURES, TOOLS

Tool for pressing out cylindrical roller bearing in drive/reduction gear end shield

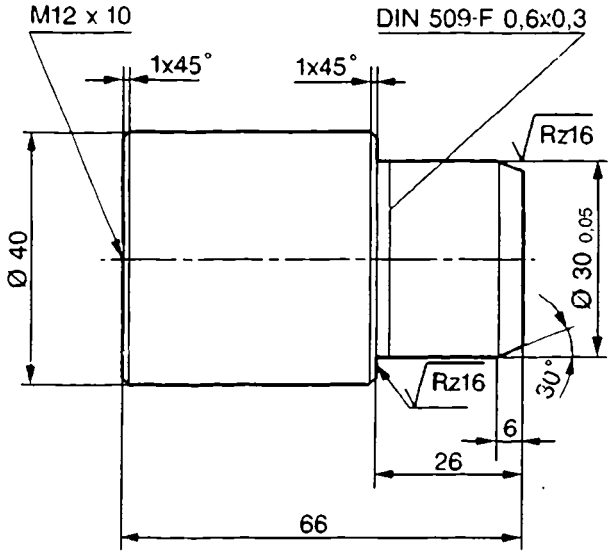
Mandrel: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: I22/1 Fig.: I21/2

KMS00546



$\sqrt{Rz63}$ ($\sqrt{Rz16}$)

TESTERS, FIXTURES, TOOLS

Tool for pressing out cylindrical roller bearing in drive/reduction gear end shield

Thrust piece: to be improvised

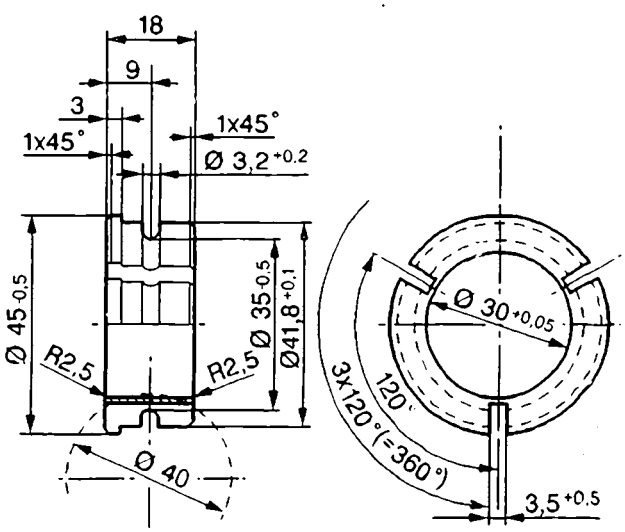
NOTE "X" (refer to drawing):
Separate (3-part) at these locations after finish-machining

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: I23/1 Fig.: I22/2

KMS00547



√Rz63

TESTERS, FIXTURES, TOOLS

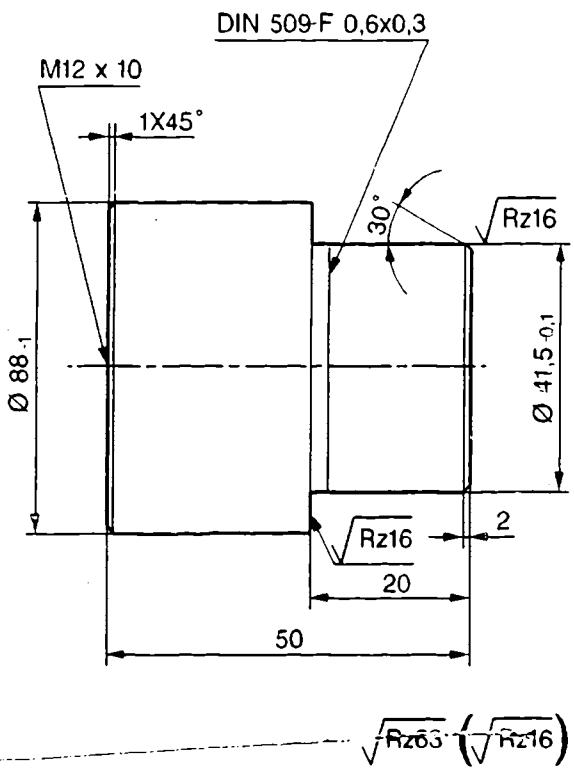
Pressing-in mandrel for
cylindrical roller bearing
in drive/reduction gear
end shield: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: I24/1 Fig.: I23/2

KMS00548



TESTERS, FIXTURES, TOOLS

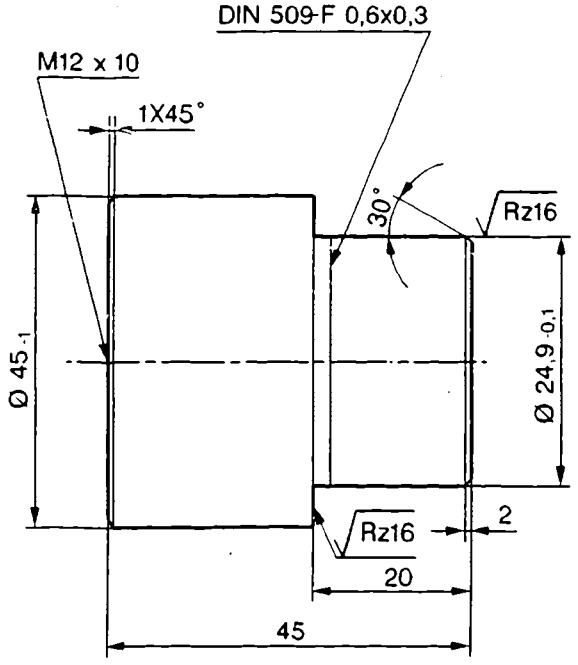
Pressing-in mandrel for needle bearing in drive end shield: to be improvised

Recommended material: 1.2842 (90 MnCrV 8)

Recommended heat treatment: Haredened to 52...56 HRC

Continue: I25/1 Fig.: I24/2

KMS00549



$\sqrt{Rz63}$ ($\sqrt{Rz16}$)

TESTERS, FIXTURES, TOOLS

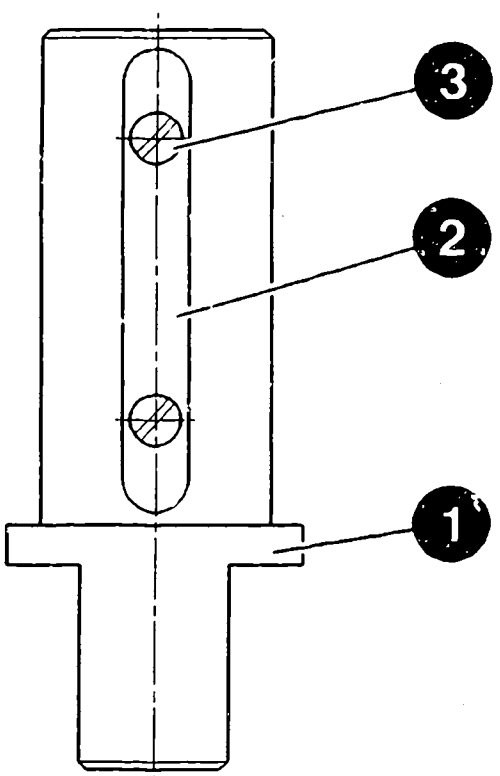
Improvised clamping pin for drive spindle with multi-plate clutch

General view

1 = Retaining pin
2 = Feather key
3 = Hexagon socket-head countersunk bolt
DIN 7991 - M4 x 12 8.8

Continue: I26/1 Fig.: I25/2

KMS00550



TESTERS, FIXTURES, TOOLS

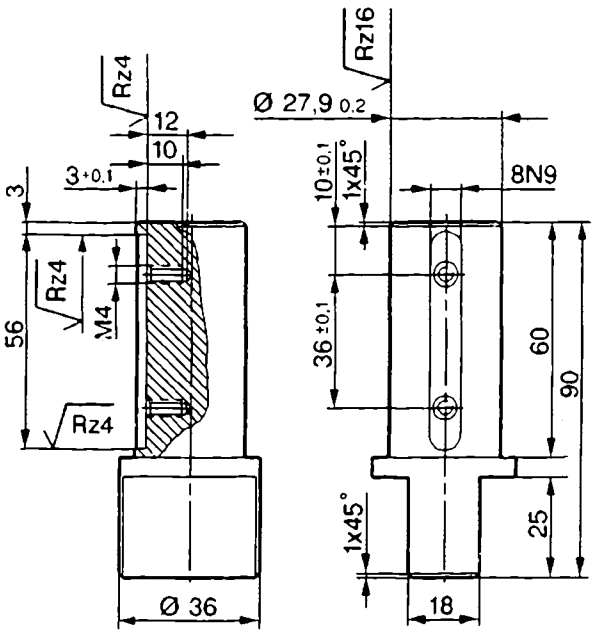
Clamping pin for drive spindle with multi-plate clutch

Retaining pin: to be improvised

Recommended material: St 52-3

Continue: I27/1 Fig.: I26/2

KMS00551



$\sqrt{Rz63}$ ($\sqrt{Rz16}$ $\sqrt{Rz4}$)

TESTERS, FIXTURES, TOOLS

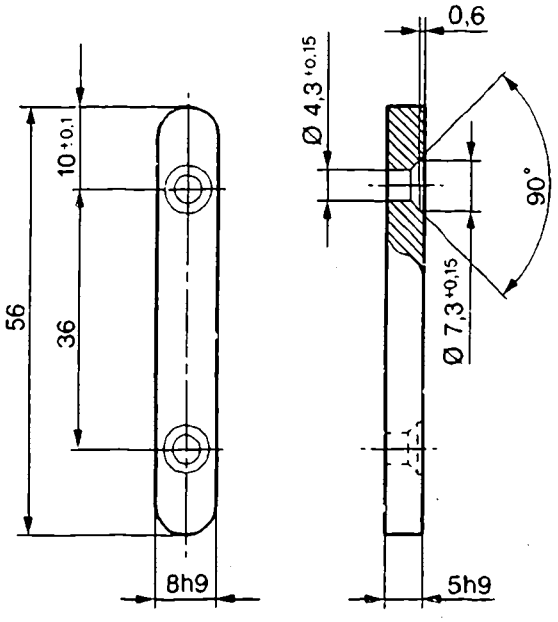
Clamping pin for drive spindle with multi-plate clutch

Feather key: reworked

Basic part:
Feather key DIN 6885-A-8x5x56-St 50

Continue: I28/1 Fig.: I27/2

KMS00552



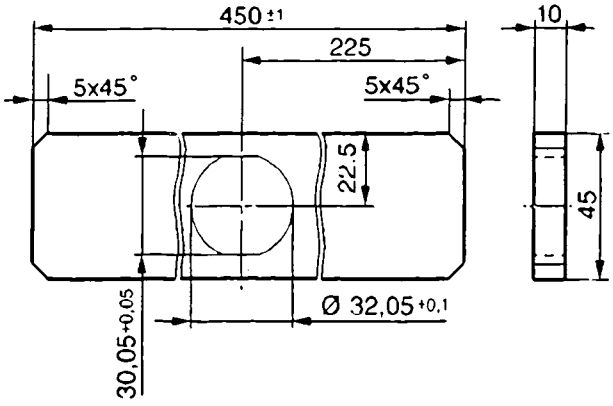
Assembly wrench for threaded ring of multi-plate clutch: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 56...60 HRC

Continue: II01/1 Fig.: I28/2

KMS00553



$\sqrt{Rz16}$

TESTERS, FIXTURES, TOOLS

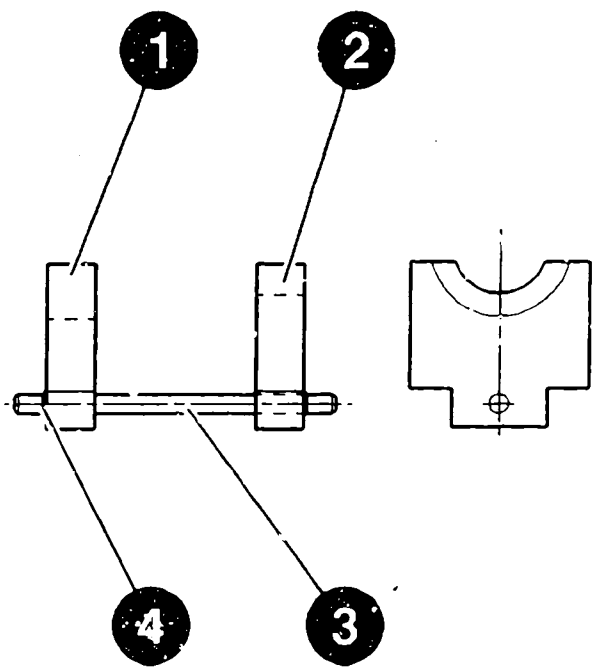
Improvised support for multi-plate clutch for caulking threaded ring

General view

1 = Support
2 = Support
3 = Retaining pin
4 = Snap ring (2x)
DIN 471-6 x 0.7

Continue: II02/1 Fig.: II01/2

KMS00561



TESTERS, FIXTURES, TOOLS

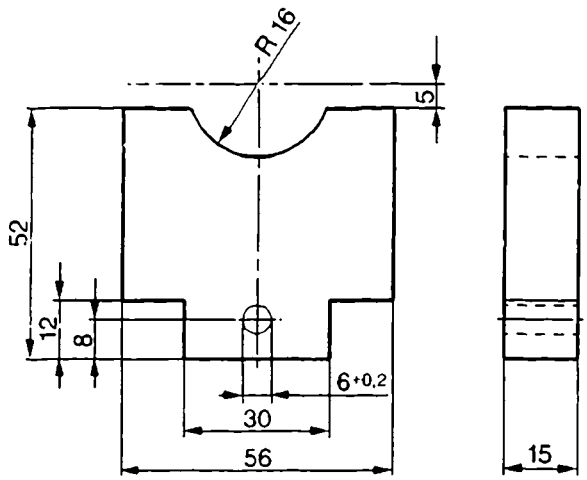
Multi-plate clutch support for caulking threaded ring

Support: to be improvised

Recommended material: St 52-3

Continue: II03/1 Fig.: II02/2

KMS00562



$\sqrt{Rz63}$

TESTERS, FIXTURES, TOOLS

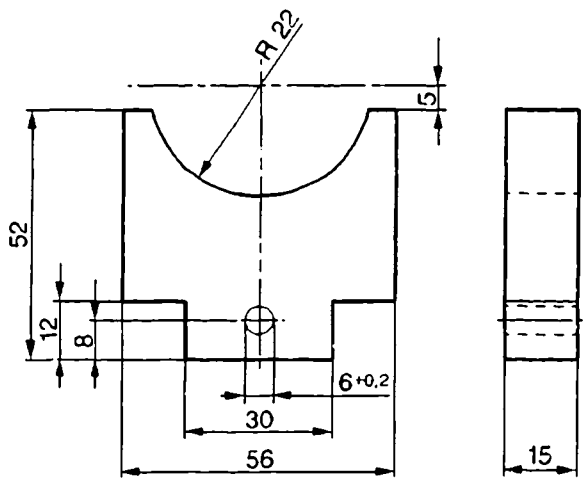
Multi-plate clutch support for caulking threaded ring

Support: to be improvised

Recommended material: St 52-3

Continue: II04/1 Fig.: II03/2

KMS00563



√Rz63

TESTERS, FIXTURES, TOOLS

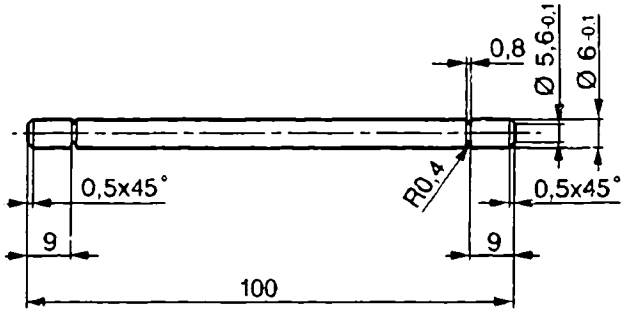
Multi-plate clutch support for caulking threaded ring

Connecting pin: to be improvised

Recommended material: St 52-3

Continue: II05/1 Fig.: II04/2

KMS00564



√Rz63

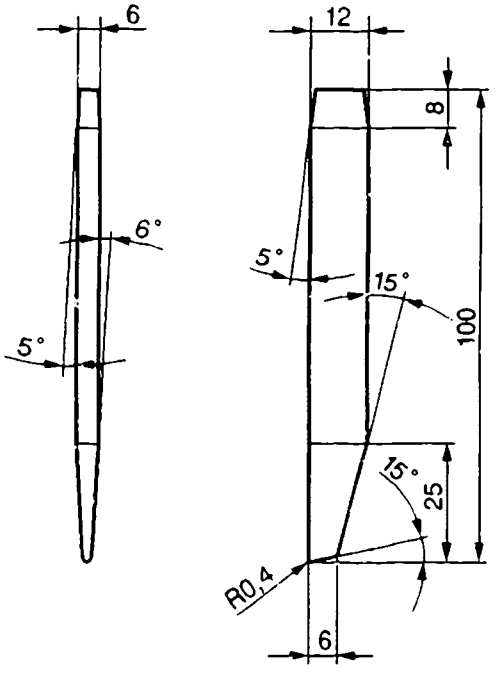
Tool for caulking
threaded ring: to be improvised

Recommended material: 60 MnSiCr 4

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: II06/1 Fig.: II05/2

KMS00555



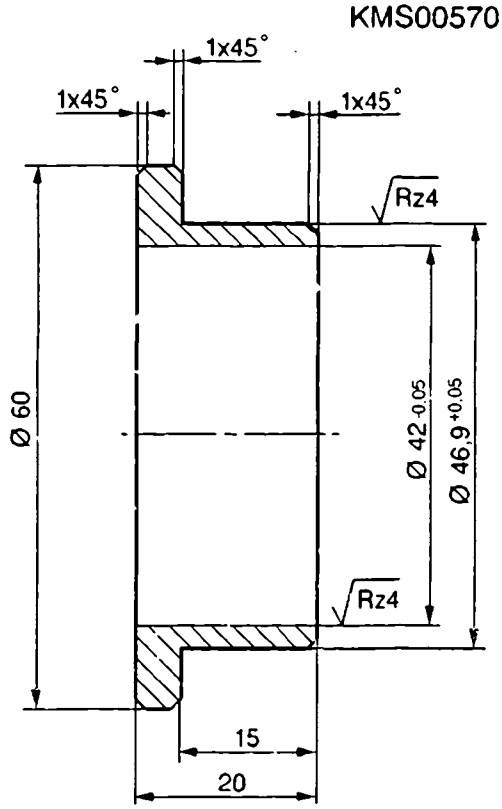
Sleeve for supporting
gear shaft on adjusting
response moment of
overload protection: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: II07/1 Fig.: II06/2

KMS00570



$\sqrt{Rz63}$ ($\sqrt{Rz4}$)

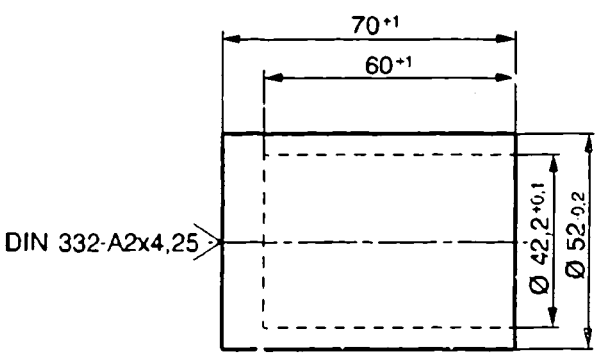
Centering sleeve for pulling deep-groove ball bearing off intermediate bearing: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: II08/1 Fig.: II07/2

KMS00568



√Rz63

TESTERS, FIXTURES, TOOLS

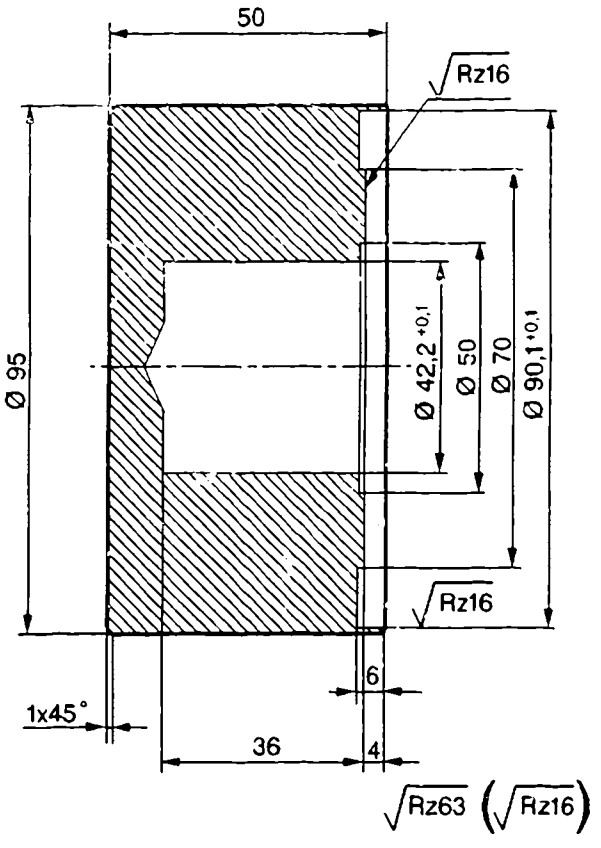
Tool for pressing deep-groove ball bearing onto intermediate bearing: to be improvised

Recommended material: 1.2842 (90 MnCrV 8)

Recommended heat treatment: Hardened to 52...56 HRC

Continue: II09/1 Fig.: II08/2

KMS00569



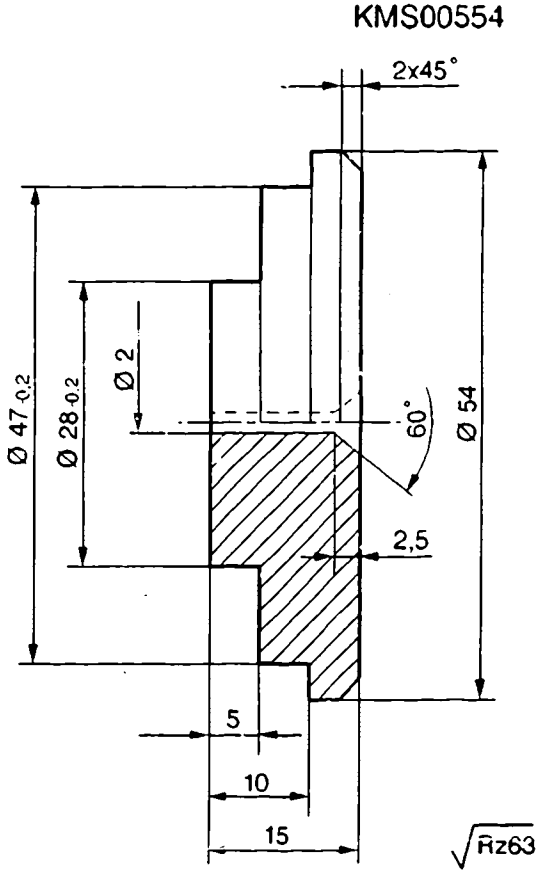
TESTERS, FIXTURES, TOOLS

Thrust piece for supporting armature on undercutting saw/ for pulling off intermediate bearing: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: II10/1 Fig.: II09/2



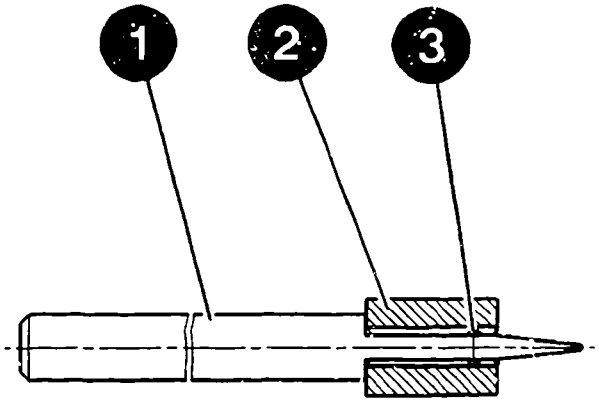
Improvised tool for pressing out needle bearing in armature

General view

1 = Mandrel
2 = Sleeve (2-piece)
3 = Rivet DIN 660 - 3 x 8

Continue: II11/1 Fig.: II10/2

KMS00565



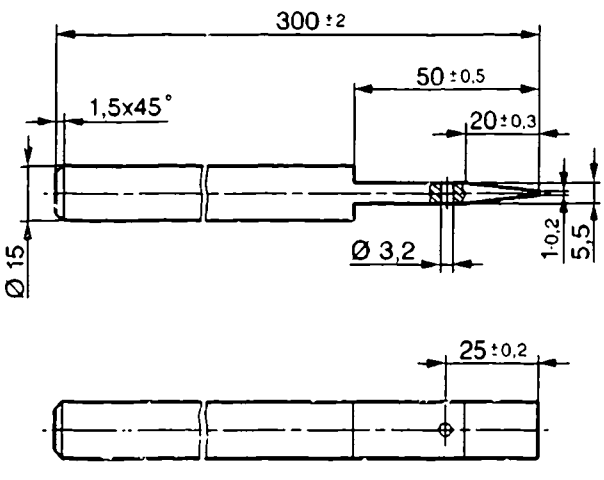
Tool for pressing out needle bearing in armature

Mandrel: to be improvised

Recommended material: St 52-3

Continue: II12/1 Fig.: II11/2

KMS00556



$\sqrt{Rz63}$

TESTERS, FIXTURES, TOOLS

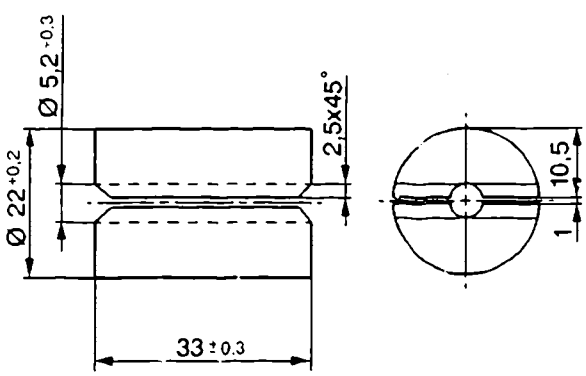
Tool for pressing out needle bearing in armature

Sleeve (2-piece): to be improvised

Recommended material: St 52-3

Continue: II13/1 Fig.: II12/2

KMS00557



√Rz63

TESTERS, FIXTURES, TOOLS

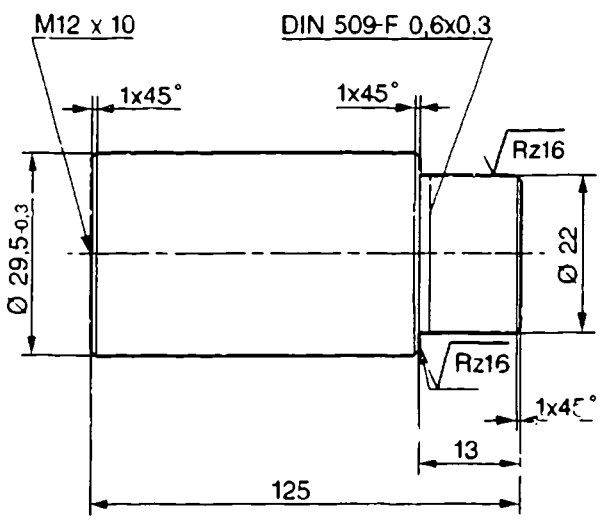
Pressing-in mandrel for needle bearing in armature: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 52...56 HRC

Continue: II14/1 Fig.: II13/2

KMS00566



$\sqrt{Rz63}$ ($\sqrt{Rz16}$)

TESTERS, FIXTURES, TOOLS

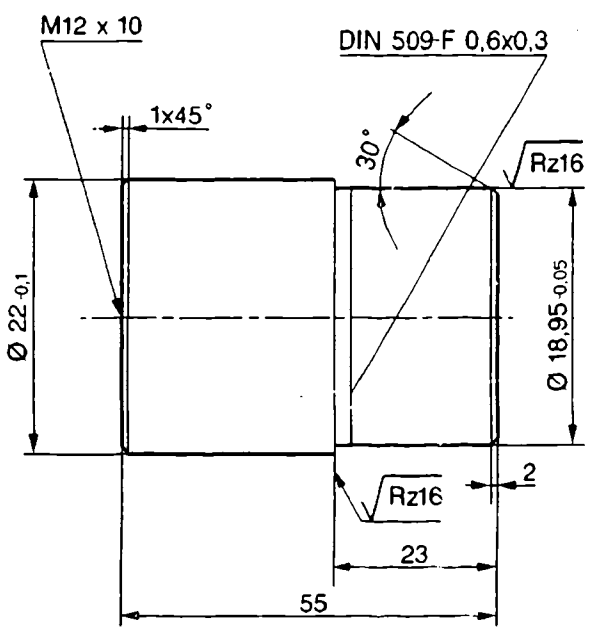
Pressing-in mandrel for bushing in armature: to be improvised

Recommended material: 1.2842 (90 MnCrV 8)

Recommended heat treatment: Hardened to 52...56 HRC

Continue: II15/1 Fig.: II14/2

KMS00559



$\sqrt{Rz63}$ ($\sqrt{Rz16}$)

TESTERS, FIXTURES, TOOLS

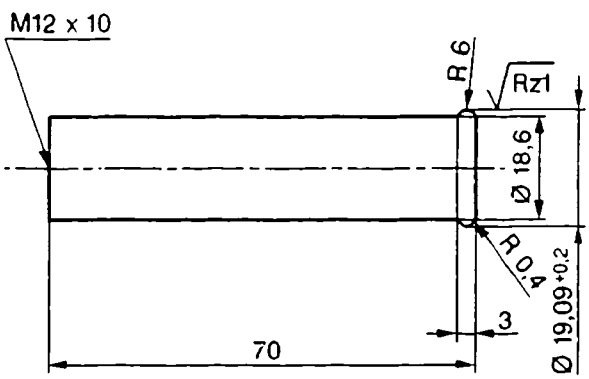
Smoothing mandrel
for bushing in
armature: to be improvised

Recommended material:
1.2842 (90 MnCrV 8)

Recommended heat treatment:
Hardened to 56...60 HRC

Continue: I01/1 Fig.: II15/2

KMS00560



$\sqrt{Rz63}$ ($\sqrt{Rz1}$)

MECHANICAL TEST SPECIFICATIONS AND SETTINGS

As-new commutator diameter	80 mm
Commutator minimum diameter:	77 mm
Brush contact force per compression spring:	9,0...13,5 N
As-new carbon brush dimension:	26,5 mm
Min. carbon brush length:	18 mm

Continue: II16/2

MECHANICAL TEST SPECIFICATIONS AND SETTINGS

Armature axial play:	0,2...0,4 mm
Gear shaft axial play:	0,5...1,3 mm
Initial force of return spring on engagement rod:	80...100 N
Ultimate force of return spring on engagement rod:	125...145 N

Continue: II17/1

MECHANICAL TEST SPECIFICATIONS AND SETTINGS

Backlash:	0,7...0,9 mm
Pinion - ring gear gap:	1,5...4,5 mm
Radial runout	
- Commutator:	< 0,03 mm
- Armature laminated core:	< 0,1 mm
Armature travel/control relay:	3,1...3,5 mm

Continue: II17/2

MECHANICAL TEST SPECIFICATIONS AND SETTINGS

Multi-plate clutch

* Overrunning torque:	0,6...1,0 Nm
* Response moment of overload protection	
- 0 001 60. ...:	350...420 Nm
- 0 001 61. ...:	420...500 Nm

Continue: II18/1

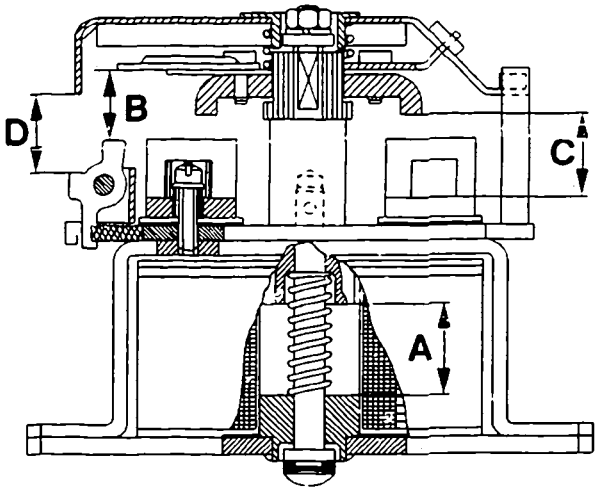
MECHANICAL TEST SPECIFICATIONS AND SETTINGS

Starting-motor solenoid settings

Dimension A:	24,8...25,2 mm
Dimension B.	19,5...20,1 mm
Dimension C:	22,1...22,7 mm
Dimension D:	23,0...23,5 mm

Continue: I01/1 Fig.: II18/2

KMS00572



ELECTRICAL TEST SPECIFICATIONS AND SETTINGS

Shunt winding resistance

- Type 24 V/18 kW:	0,75...0,83 Ohm
- Type 32 V/36 V:	26,1...28,8 Ohm

Control relay winding resistance

All types:	4,9...5,1 Ohm

Min. voltage with solenoid switch mounted on starter

- Type 24 V:	14 V
- Type 32 V:	17 V
- Type 36 V:	19 V

Continue: II19/2

ELECTRICAL TEST SPECIFICATIONS AND SETTINGS

Brake winding resistance, Type 24 V

* 10 kW:	0,05...0,06 mm
- 0 001 602 002	
* 15 kW:	0,06...0,08 Ohm
- 0 001 601 ...	
- 0 001 603 ...	
- 0 001 608 ...	
* 18 kW:	0,05...0,06 Ohm
- 0 001 613 ...	
- 0 001 615 ...	

Continue: II20/1

ELECTRICAL TEST SPECIFICATIONS AND SETTINGS

Brake winding resistance, Type 32/36 V

* 18 - 25 kW: 0,08...0,09 Ohm
  - 0 001 6.. ...

Insulation resistance
All types: > 0,5 MOhm

Continue: II20/2

ELECTRICAL TEST SPECIFICATIONS AND SETTINGS

Idling test specifications, Type 24 V

Type no.	Voltage (V)	Current (A)	Revs (1/min)
001 601 ...	23	< 170	> 6000
001 602 002	23	< 115	> 4800
001 603 ...	23	< 170	> 4200
001 608 003	23	< 140	> 3700
001 608 005	23	< 140	> 3700
001 613 ...	23	< 210	> 4900
001 615 ...	23	< 150	> 4500

Continue: II21/1

ELECTRICAL TEST SPECIFICATIONS AND SETTINGS

Idling test specifications, Type 32 V

Type no.	Voltage (V)	Current (A)	Revs (1/min)
001 6.. ...	31	< 120	> 6800

Idling test specifications, Type 36 V

Type no.	Voltage (V)	Current (A)	Revs (1/min)
001 6.. ...	35	< 120	> 6800

Continue: I01/1

TIGHTENING TORQUES

* Uni-Stop nut for starter pinion attachment: 35...45 Nm
* Micro-encapsulated bolt for pinion attachment on starters with reduction gear: 42...50 Nm
* Micro-encapsulated bolts for attachment of intermediate bearing: 7...8 Nm
* Threaded ring of multi-plate clutch: 80...100 Nm
* Bolts for attachment of pole shoes: 41...51 Nm

Continue: II22/2

TIGHTENING TORQUES

* Hexagon nut for attaching tripping lever to starting-motor solenoid: 10...15 Nm
* Bolts for attaching commutator end shield: 5,5...6,8 Nm
* Bolts for attaching drive end shield: 9...11 Nm
* Cheese-head bolts for attaching starting-motor solenoid: 5,5...6,8 Nm
* Hexagon bolts for attaching starting-motor solenoid: 8,4...10,5 Nm

Continue: I01/1

LUBRICANTS AND SEALANTS/ LUBRICATION SCHEDULE

GENERAL
Commutator and carbon brushes are to be kept free of grease and oil.

Greased parts are to be degreased before re-lubricating them.
ATTENTION: Avoid excessive use of grease.

Lubricate all bright parts after cleaning with anti-corrosion oil.
01 41 v 2: 5 701 351 610

Soak new bushings for 8 hours in suitable oil before installing.
Oil VS 13834-01: 5 962 260 6..

Continue: II23/2

LUBRICANTS AND SEALANTS/ LUBRICATION SCHEDULE

USAGE

* Anti-corrosion oil
  01 41 v 2: 5 701 351 610
  - For all bright parts -

* Sealing putty
  Kk 1 v 3: 5 703 452 150
  - For one/two-piece clamping strap

* Combination cellulose nitrate lacquer
  Ft 58 v 3: 5 899 607 017
  - For windings and coils -

Continue: II24/1

LUBRICANTS AND SEALANTS/ LUBRICATION SCHEDULE

USAGE

* Hylomar sealant
  VS 9844 Kk: 5 927 350 002
  - For bolts, caps, cover plates, drive end shields and covers

* Locking compound: comm. avail.
  - For countersunk head bolts for attaching cover plates -

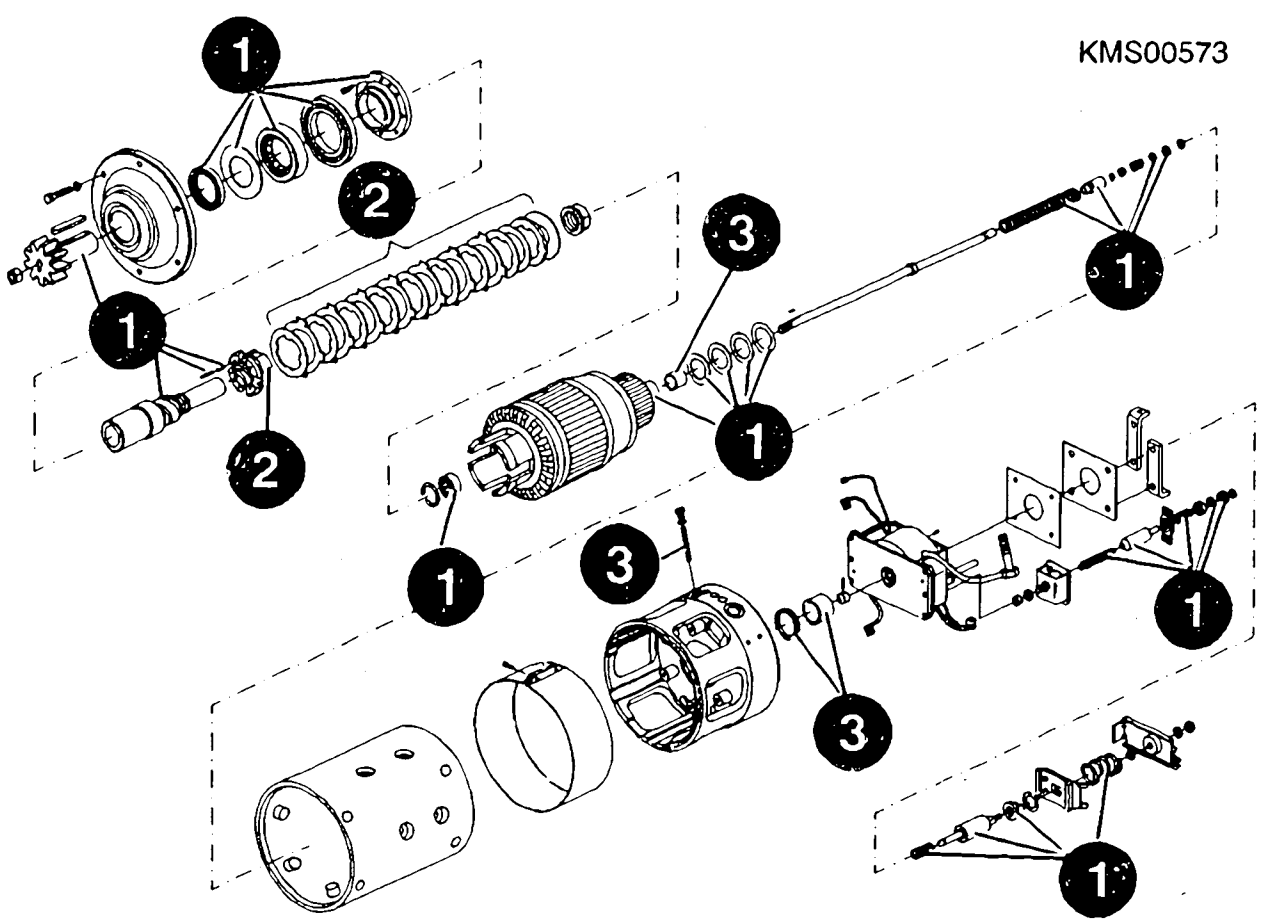
Continue: II25/1

LUBRICANTS AND SEALANTS/ LUBRICATION SCHEDULE

STARTER LUBRICATION SCHEDULE

1	=	Grease VS 10832-Ft	5 932 240 150
2	=	Grease Ft2 v 3 (lead-free)	5 700 082 0..
3	=	Oil VS 13834-01	5 962 260 6..

Continue: II26/1 Fig.: II25/2



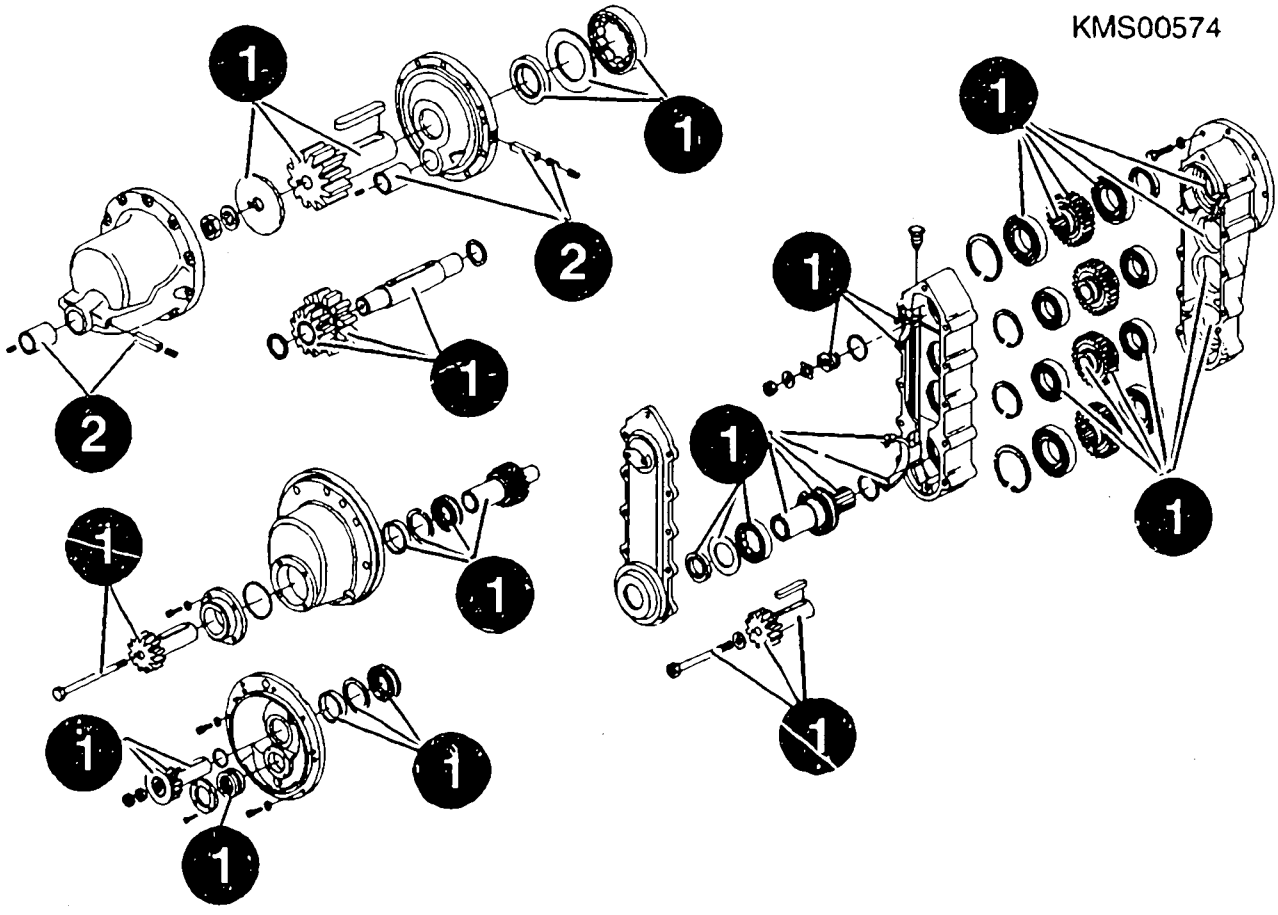
LUBRICANTS AND SEALANTS/ LUBRICATION SCHEDULE

REDUCTION GEAR LUBRICATION SCHEDULE

1 = Grease VS 10832-Ft 5 932 240 150

2 = Oil VS 13834-01 5 962 260 6..

Continue: I01/1 Fig.: II26/2



CIRCUIT DIAGRAM TABLE

Continue: II27/2

CIRCUIT DIAGRAM TABLE

NOTE:
The circuit diagrams for starters with start-inhibit and repeating relay/starters in parallel operation also apply to other basic starter types.

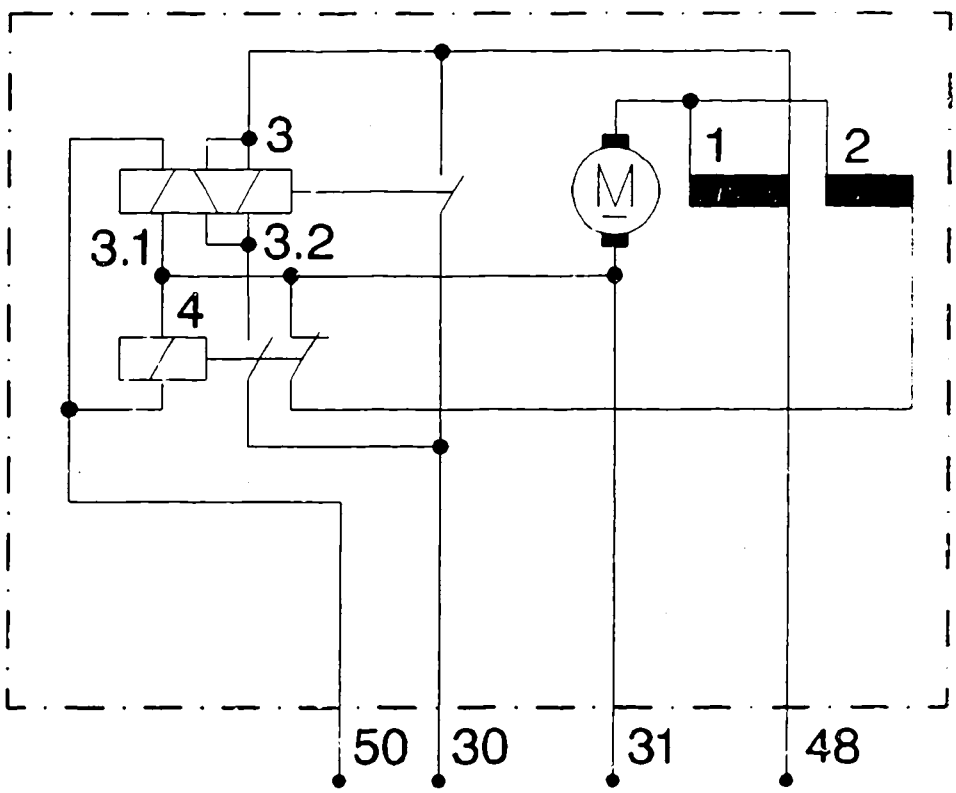
Continue: I01/1

T-STARTER WITH BRAKE WINDING

1 = Series winding
2 = Brake winding
3 = Starting-motor solenoid
3.1 = Holding winding
3.2 = Pull-in and opposing winding
4 = Control relay

Continue: I127/1 Fig.: II28/2

KMS00577

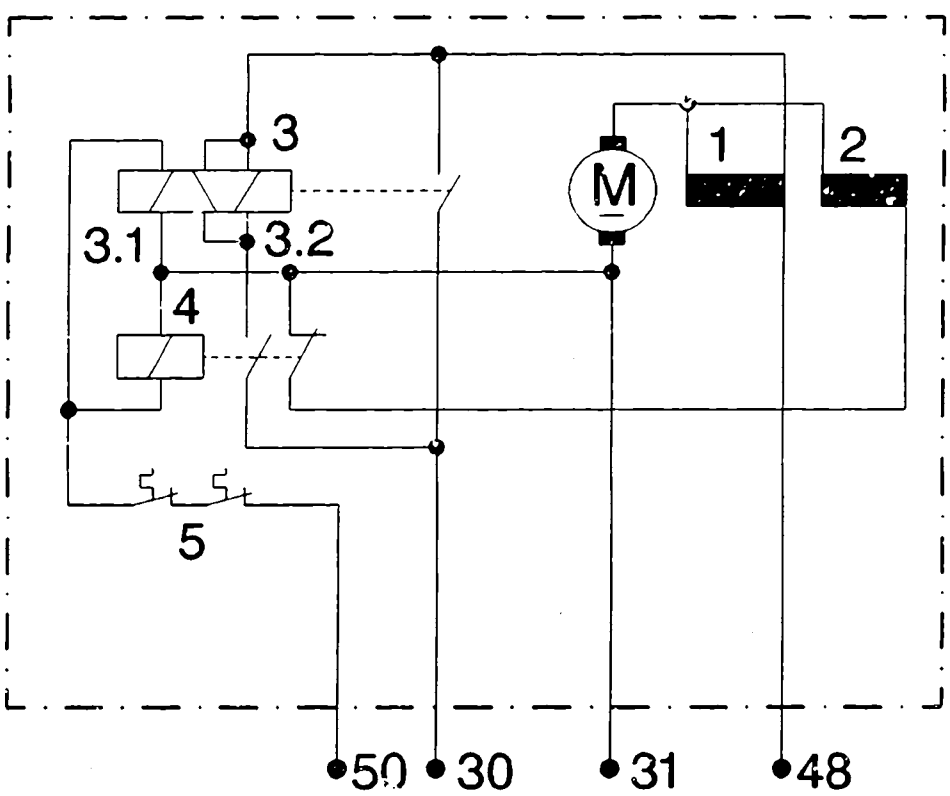


T-STARTER WITH BRAKE WINDING AND THERMOSWITCH

1 = Series winding
2 = Brake winding
3 = Starting-motor solenoid
3.1 = Holding winding
3.2 = Pull-in and opposing winding
4 = Control relay
5 = Thermoswitch

Continue: II27/1 Fig.: III01/2

KMS00578



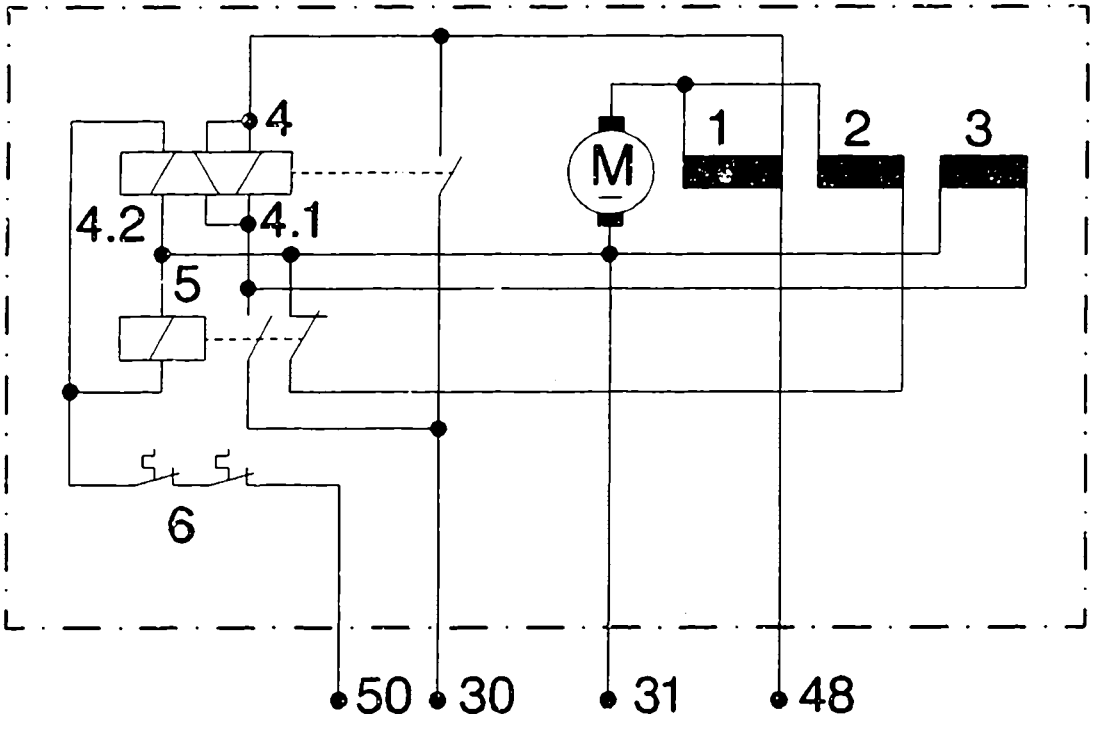
T-STARTER WITH SHUNT WINDING

With brake winding and
thermoswitch

1 = Series winding
2 = Brake winding
3 = Shunt winding
4 = Starting-motor solenoid
4.1 = Holding winding
4.2 = Pull-in and opposing winding
5 = Control relay
6 = Thermoswitch

Continue: II27/1 Fig.: III02/2

KMS00579



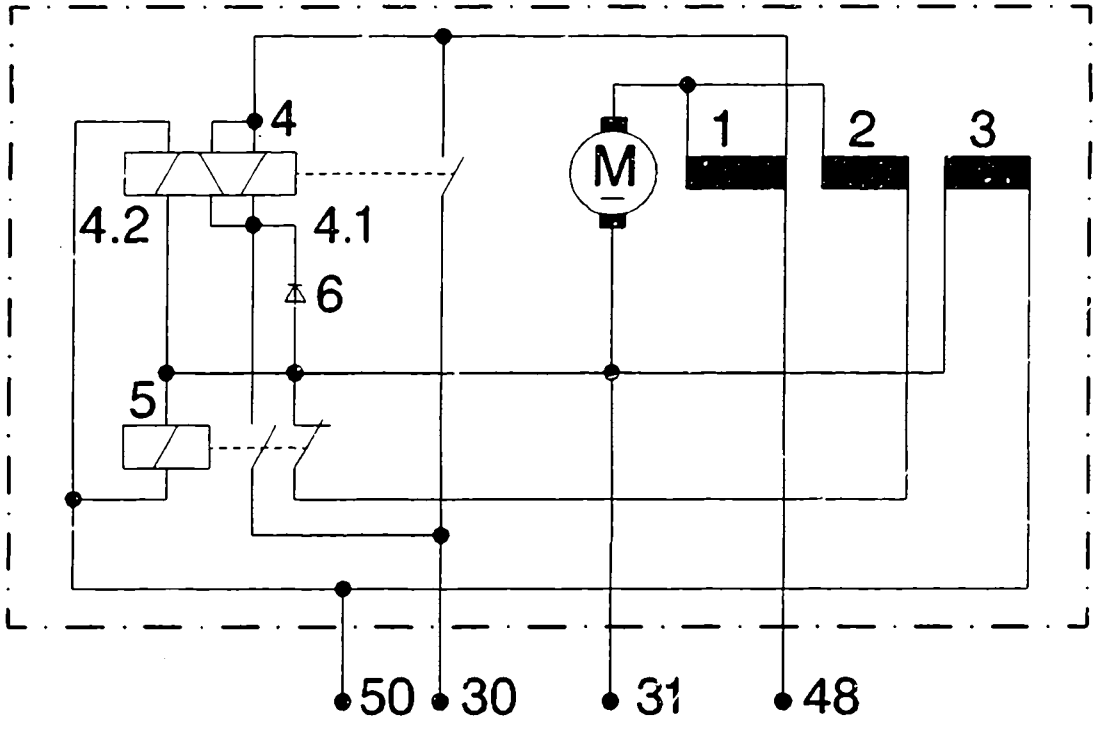
T-STARTER WITH DIODE AND SHUNT WINDING

With brake winding and
thermoswitch

1 = Series winding
2 = Brake winding
3 = Shunt winding
4 = Starting-motor solenoid
4.1 = Holding winding
4.2 = Pull-in and opposing winding
5 = Control relay
6 = Diode

Continue: II27/1 Fig.: III03/2

KMS00668

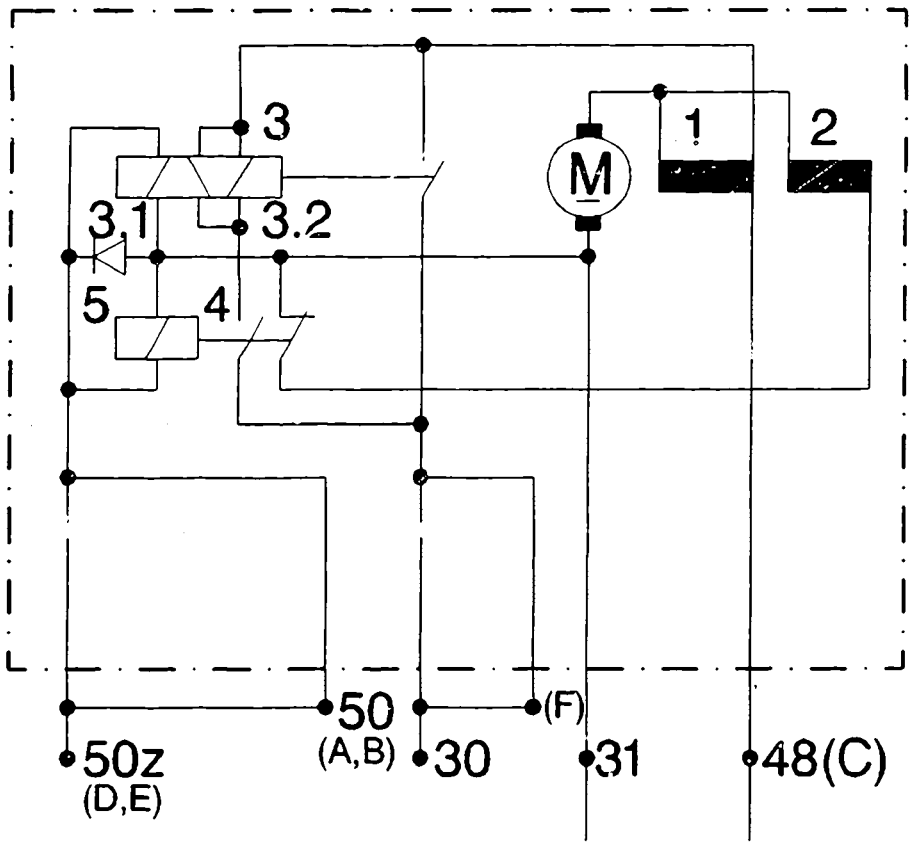


TF-STARTER WITH DIODE
TYPE 0 001 613 ...

1 = Series winding
2 = Brake winding
3 = Starting-motor solenoid
3.1 = Holding winding
3.2 = Pull-in and opposing winding
4 = Control relay
5 = Diode

Continue: II27/1 Fig.: III04/2

KMS00580



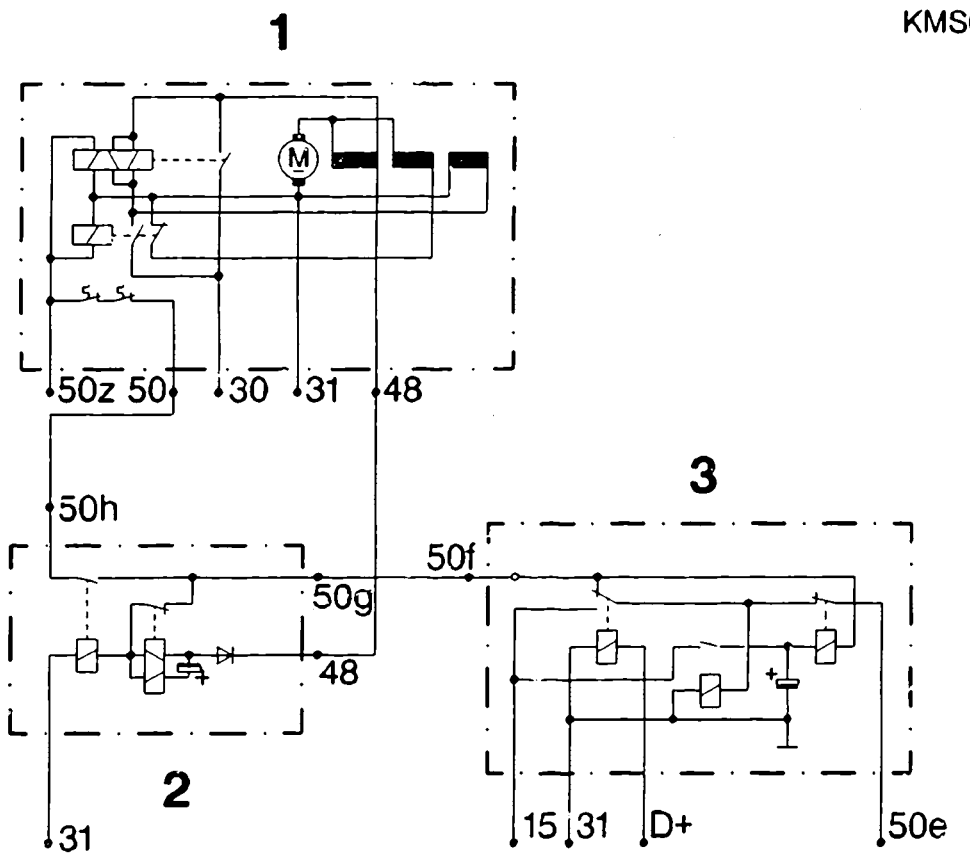
T-STARTER WITH START-INHIBIT AND REPEATING RELAY

VERSION 1:
- Mechanical start repeating relay
- Mechanical start-inhibit relay

1 = Starter
2 = Start repeating relay
3 = Start-inhibit relay

Continue: III06/1 Fig.: III05/2

KMS00581



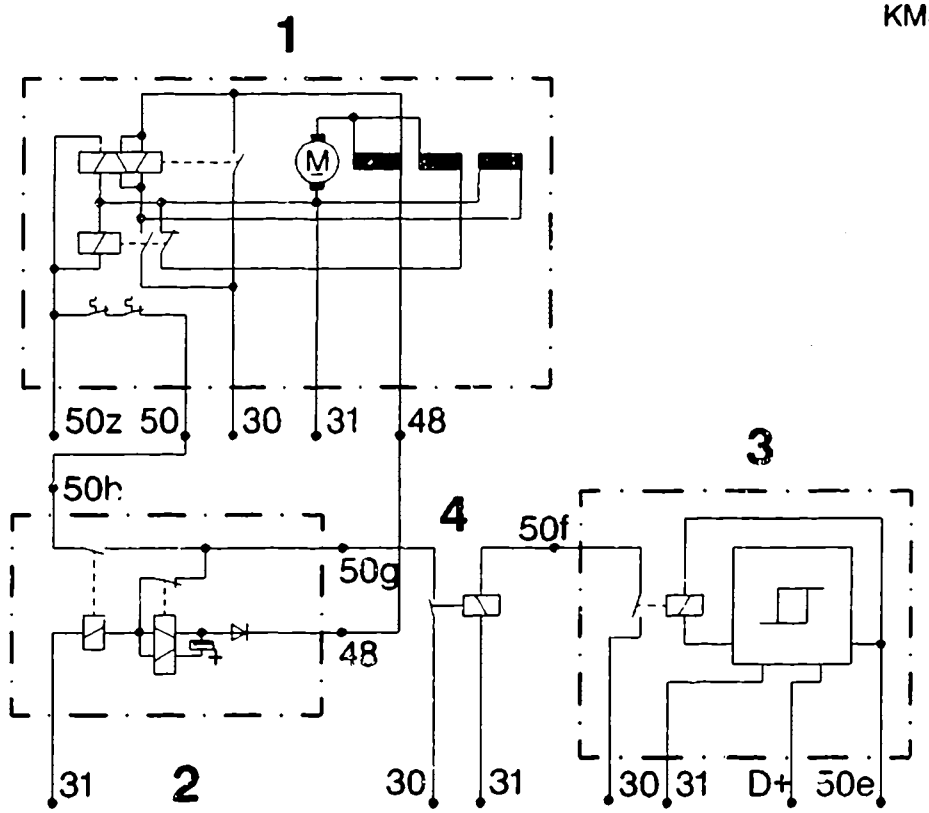
T-STARTER WITH START-INHIBIT AND REPEATING RELAY

VERSION 2:
- Mechanical start repeating relay
- Electronic start-inhibit relay
- Auxiliary relay

1 = Starter
2 = Start repeating relay
3 = Start-inhibit relay
4 = Auxiliary relay

Continue: III07/1 Fig.: III06/2

KMS00582



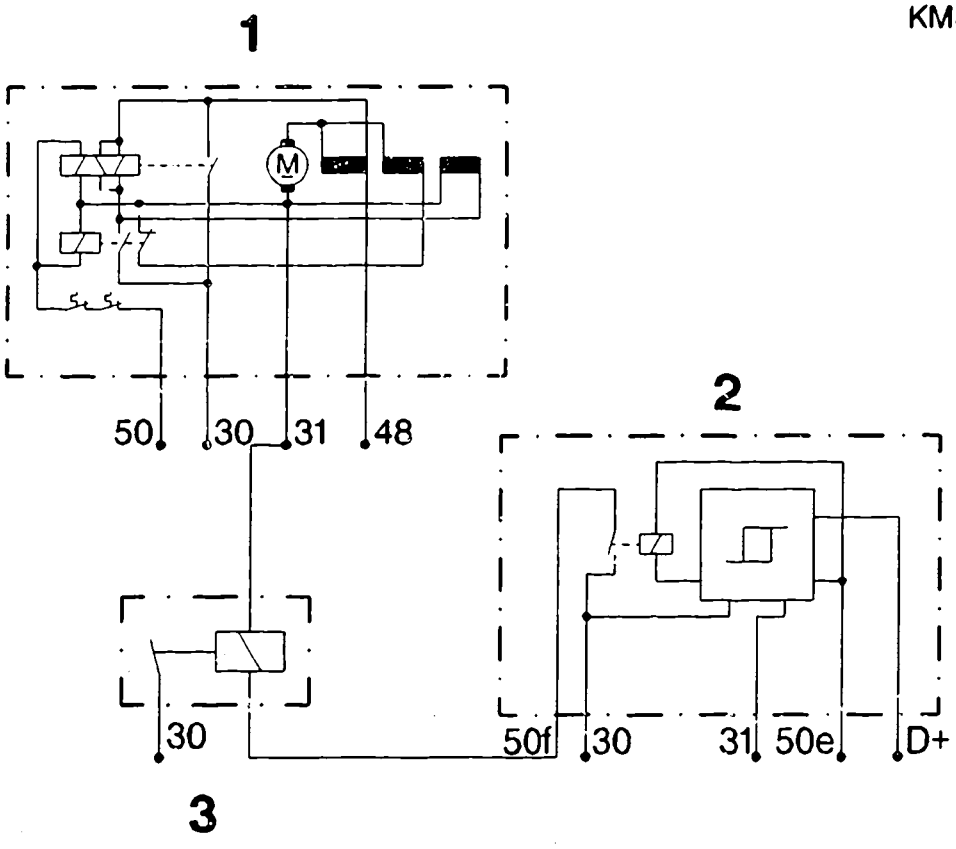
T-STARTER WITH START-INHIBIT AND REPEATING RELAY

VERSION 3:
- Combined start-inhibit and repeating relay (not for parallel operation)
- Auxiliary relay

1 = Starter
2 = Combined start-inhibit and repeating relay
3 = Auxiliary relay

Continue: II27/2 Fig.: III07/2

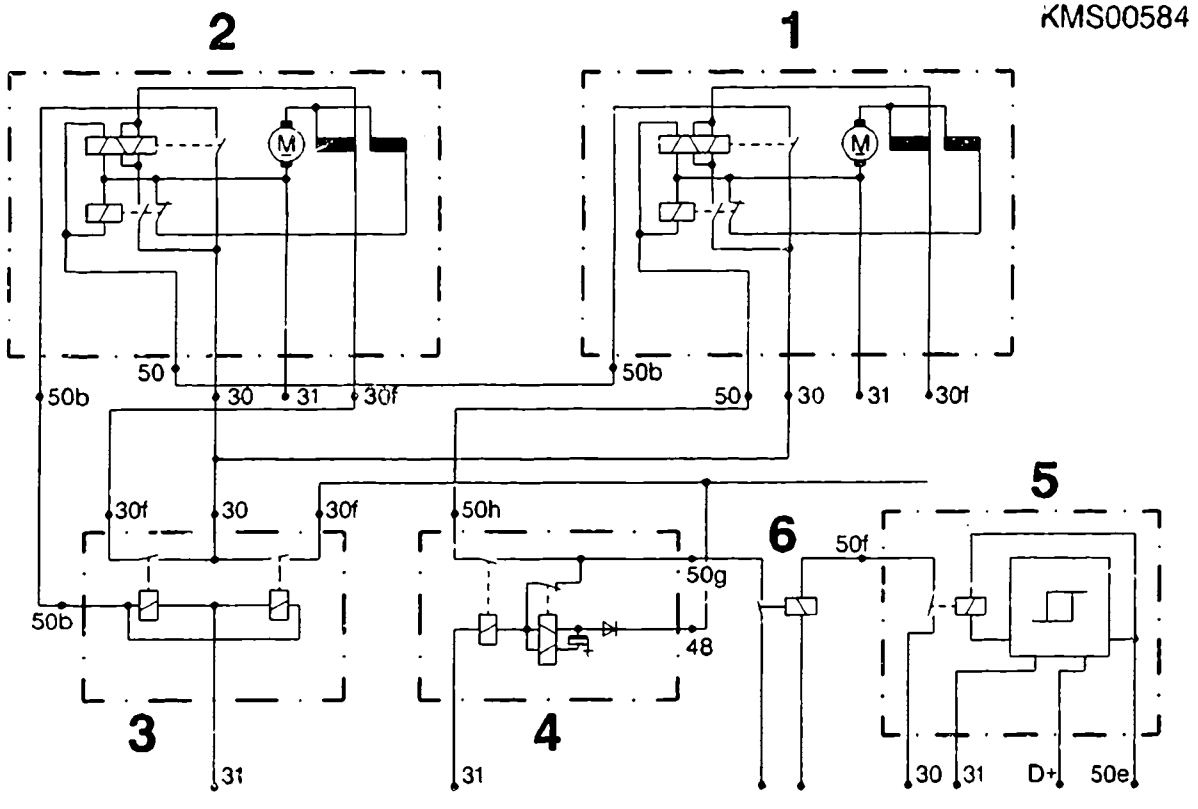
KMS00583



T-STARTER IN PARALLEL OPERATION

1 = Starter 1
2 = Starter 2
3 = Twin starting relay
4 = Start repeating relay
5 = Start-inhibit relay
6 = Auxiliary relay

Continue: II27/2 Fig.: III08/2



STARTER DISASSEMBLY TABLE

Continue: III09/2

STARTER DISASSEMBLY TABLE

Continue: I01/1

DISASSEMBLING PINION (TYPE TB)

Clamp starter in clamping support.

Unfasten Uni-Stop nut (1) for attaching pinion. Use torquemeter (2) to provide pinion support.

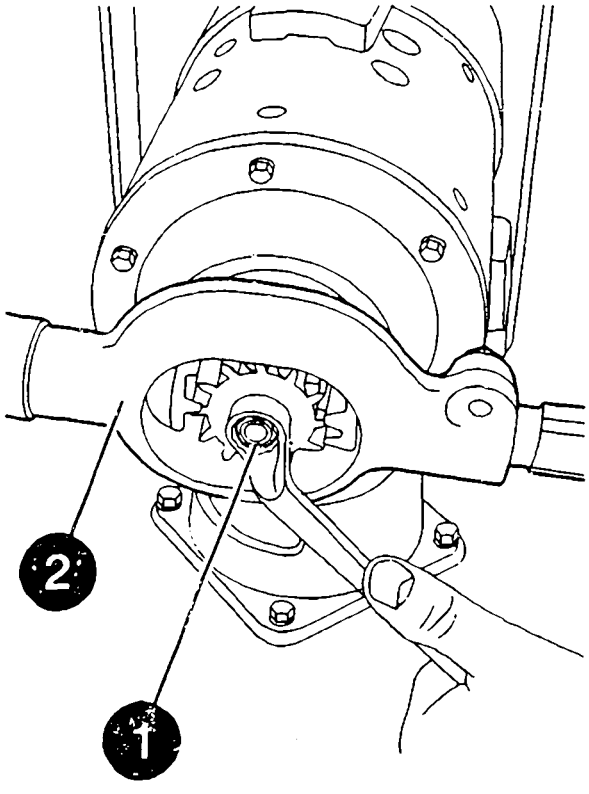
Pull pinion out of gear shaft.

Take feather key out of engagement rod.

Clamping support:	0 986 619 362
Torquemeter:	0 986 617 166

Continue: III09/1 Fig.: III10/2

KMS00585



DISASSEMBLING REDUCTION GEAR (TYPE TE)

Clamp starter in clamping support.

Unfasten bolts of reduction gear end shield.
Fit suitable tool in recesses and prise reduction gear end shield off drive end shield.
ATTENTION: Take care not to damage fitting surfaces. Watch out for straight pins in drive end shield.

Detach reduction gear end shield with reduction gear shaft from drive end shield.

Clamping support: 0 986 619 362

Continue: III11/2

DISASSEMBLING REDUCTION GEAR (TYPE TE)

Unfasten Uni-Stop nut for pinion attachment.
Use torquemeter to provide pinion support.

Pull pinion out of gear shaft.

Take feather key out of engagement rod.

Torquemeter: 0 986 617 166

Continue: III09/1

DISASSEMBLING REDUCTION GEAR (TYPE TF 0 001 608 .../... 611)

Also Type TF 32 V/36 V - 0 001 6.. ...

Clamp starter in clamping support.

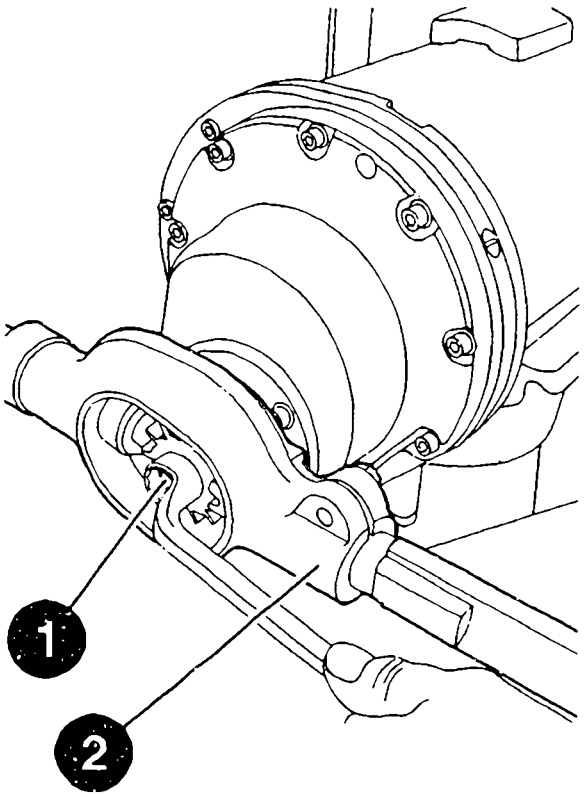
Unfasten bolt (1) for attaching pinion. Use torquemeter (2) to provide pinion support.

Pull out pinion.

Clamping support:	0 986 619 362
Torquemeter:	0 986 617 166

Continue: III13/1 Fig.: III12/2

KMS00586

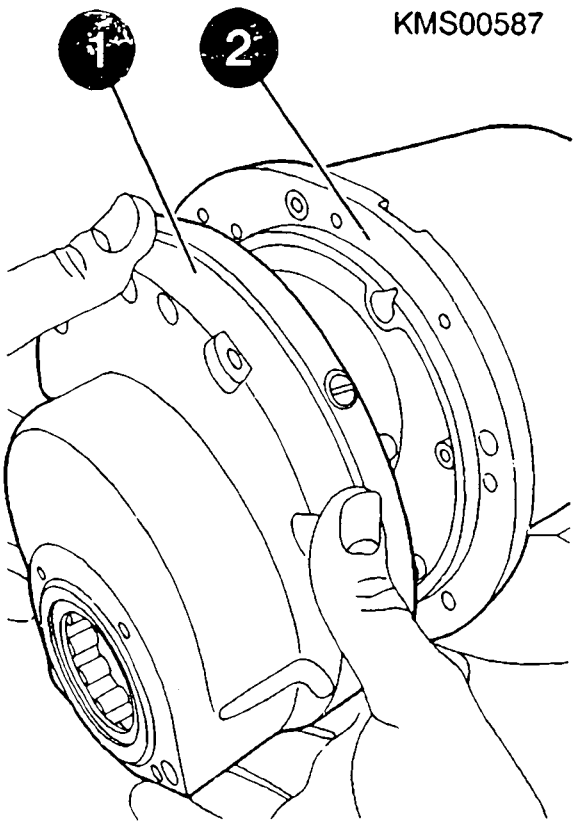


DISASSEMBLING REDUCTION GEAR (TYPE TF 0 001 608 .../... 611)

Also Type TF 32 V/36 V - 0 001 6.. ...

Unfasten cover bolts. Watch out for sealing rings.
Detach cover with O-ring if fitted (already detached in Fig.).
Unfasten bolts of reduction gear end shield (1).
Insert suitable tool in recesses and prise reduction gear end shield off drive end shield (2).
Watch out for straight pins in drive end shield.
ATTENTION: Take care not to damage fitting surfaces.

Continue: III14/1 Fig.: III13/2



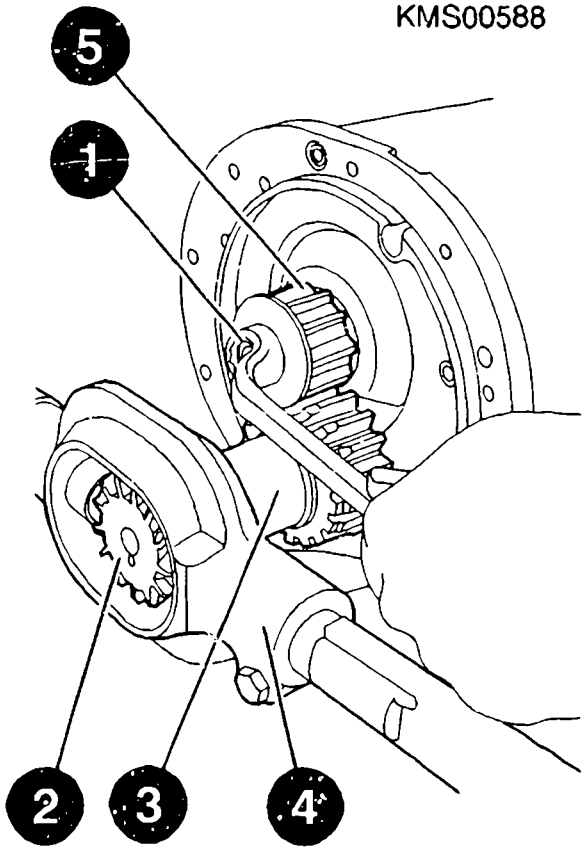
DISASSEMBLING REDUCTION GEAR (TYPE TF 0 001 608 .../... 611)

Also Type TF 32 V/36 V - 0 001 6.. ...

Unfasten Uni-Stop nut (1) for attaching pinion. To do so, insert previously dismantled pinion (2) into reduction gear shaft (3) and provide support with torquemeter (4).
Pull pinion out of gear shaft (5), pulling off reduction gear shaft (3) at the same time.
Take feather key out of engagement rod.

Torquemeter: 0 986 617 166

Continue: III09/1 Fig.: III14/2



DISASSEMBLING REDUCTION GEAR (TYPE TF 0 001 613 ...)

Clamp starter in clamping support.

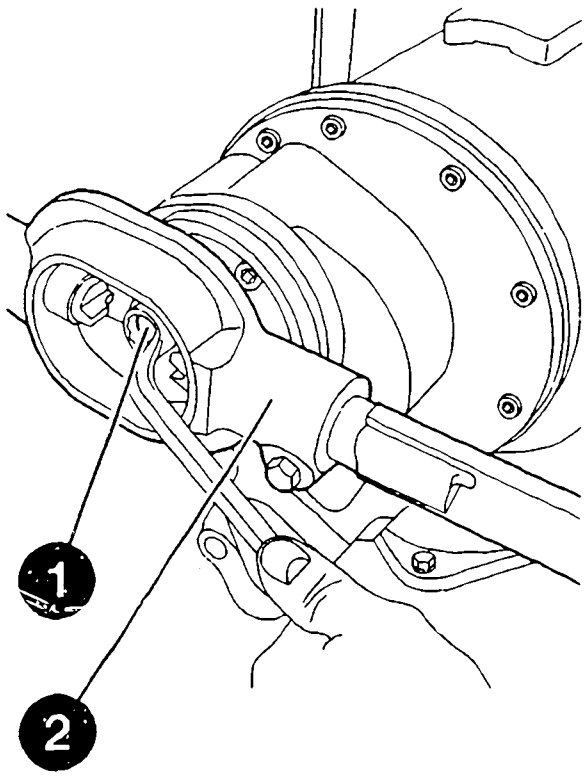
Unfasten bolt (1) for attaching pinion. Use torquemeter (2) to provide pinion support.
ATTENTION: Take care not to damage flange.

Pull out pinion.

Clamping support:	0 986 619 362
Torquemeter:	0 986 617 166

Continue: III16/1 Fig.: III15/2

KMS00589



DISASSEMBLING REDUCTION GEAR (TYPE TF 0 001 613 ...)

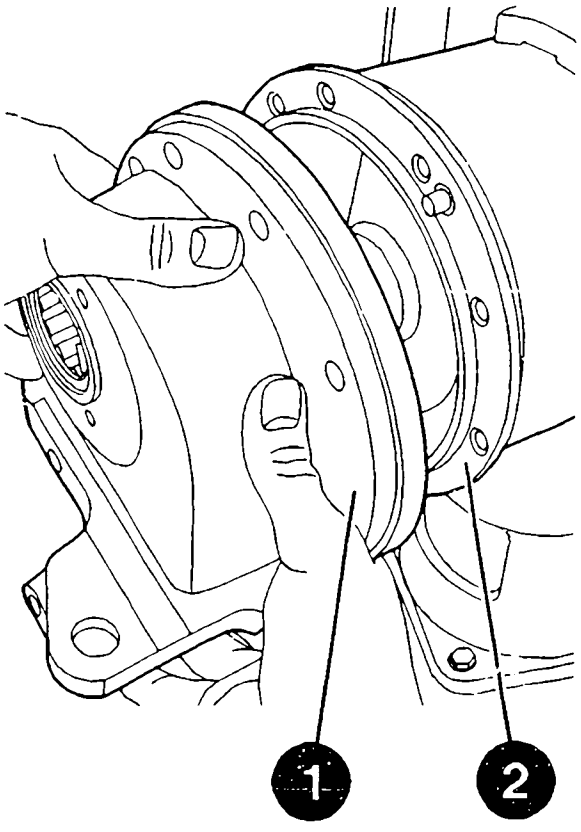
Unfasten cover bolts.
Detach cover
(already detached in Fig.).

ATTENTION: Take care not to damage seat of radial shaft oil seal.

Unfasten bolts of reduction gear end shield. Detach reduction gear end shield (1) from drive end shield (2) by tapping gently with rubber-headed hammer.
Watch out for straight pins in drive end shield.

Continue: III17/1 Fig.: III16/2

KMS00590



DISASSEMBLING REDUCTION GEAR (TYPE TF 0 001 613 ...)

Unfasten Uni-Stop nut (1) for attaching pinion. To do so, insert previously dismantled pinion (2) in reduction gear shaft (3) and provide support with torquemeter (4).

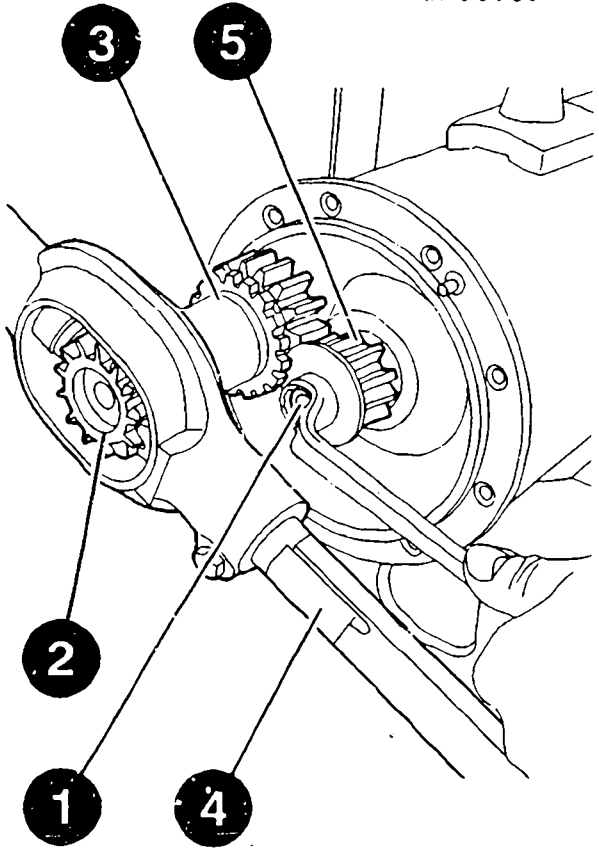
Pull pinion out of gear shaft (5) and pull off reduction gear shaft (3) at the same time.

Take feather key out of engagement rod.

Torquemeter: 0 986 617 166

Continue: III09/1 Fig.: III17/2

KMS00591

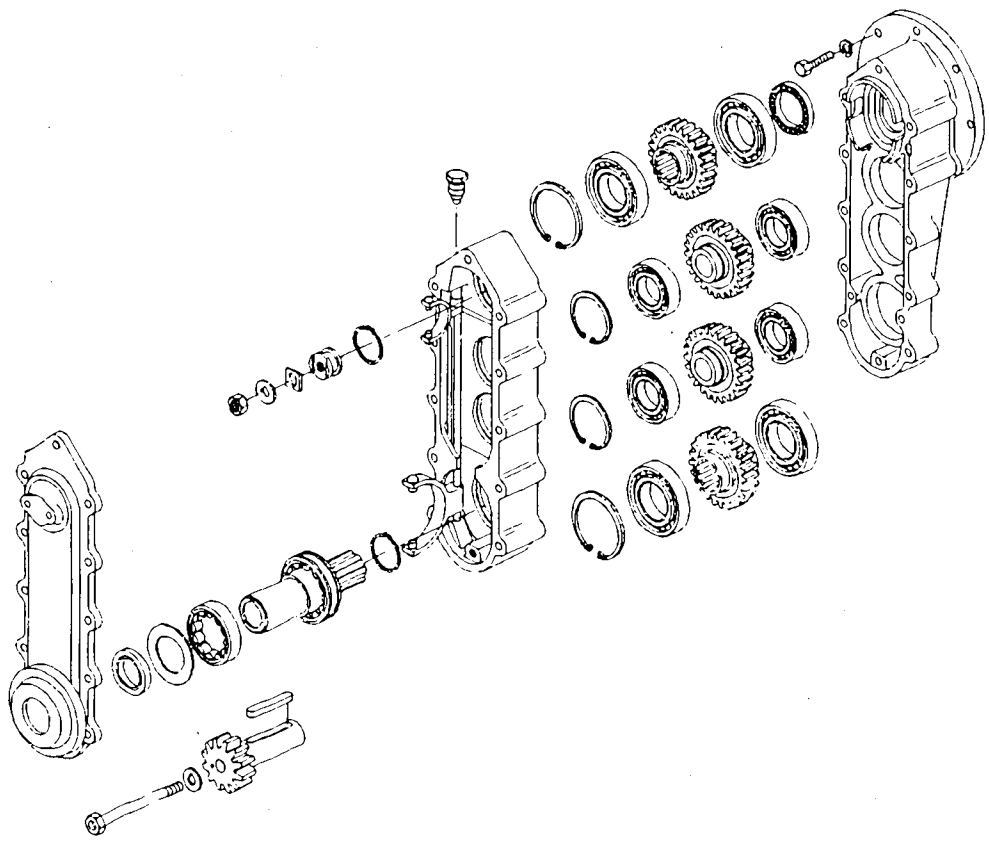


DISASSEMBLING 4-SPEED REDUCTION GEAR (TYPE TF 0 001 6.. ...)

BLOCK DIAGRAM

Continue: III19/1 Fig.: III18/2

KMS00575



DISASSEMBLING 4-SPEED REDUCTION GEAR (TYPE TF 0 001 6.. ...)

Clamp starter in clamping support.

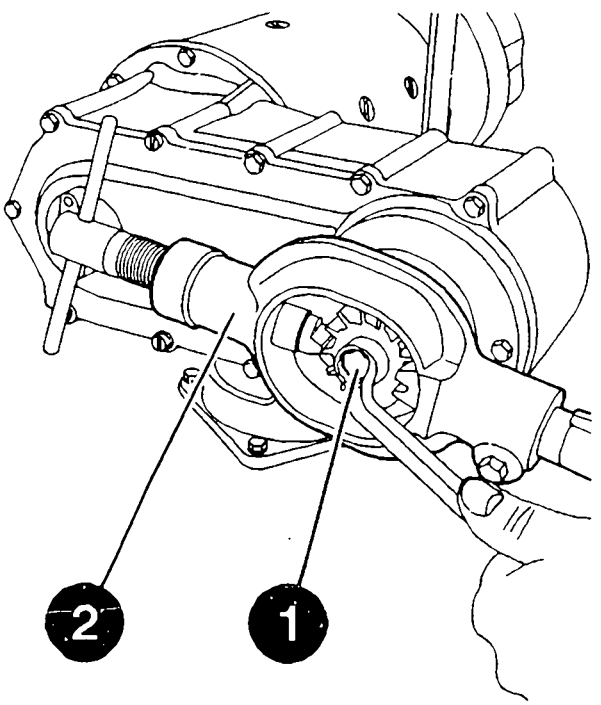
Unfasten bolt (1) for attaching pinion. Use torquemeter (2) to provide pinion support.

Pull out pinion.

Clamping support:	0 986 619 362
Torquemeter:	0 986 617 166

Continue: III20/1 Fig.: III19/2

KMS00593



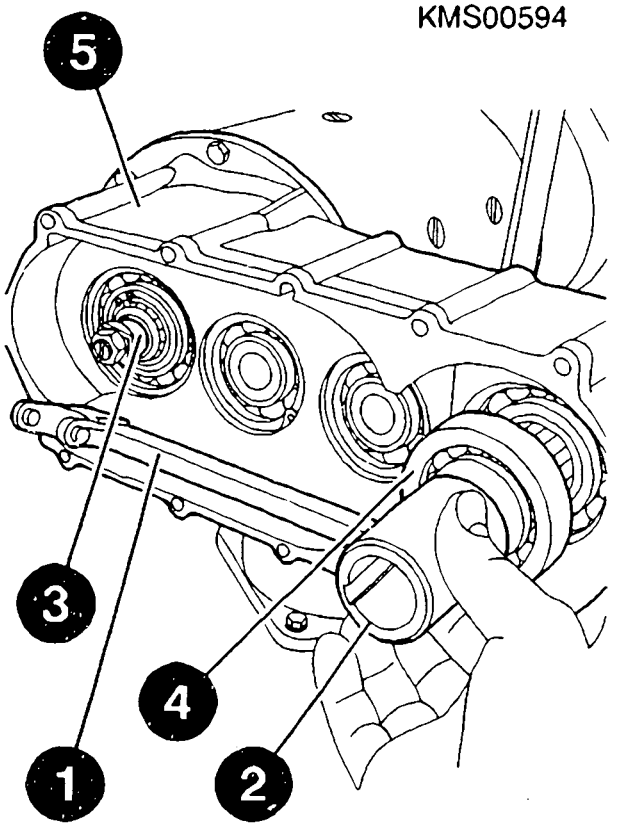
DISASSEMBLING 4-SPEED REDUCTION GEAR (TYPE TF 0 001 6.. ...)

Unfasten cover bolts.
Detach cover
(already removed in Fig.).

Disengage fork lever (1) by pulling reduction gear shaft (2) out of guide ring (3) and switching ring (4) and detach reduction gear shaft (2).
Detach housing (5).

Continue: III21/1 Fig.: III20/2

KMS00594

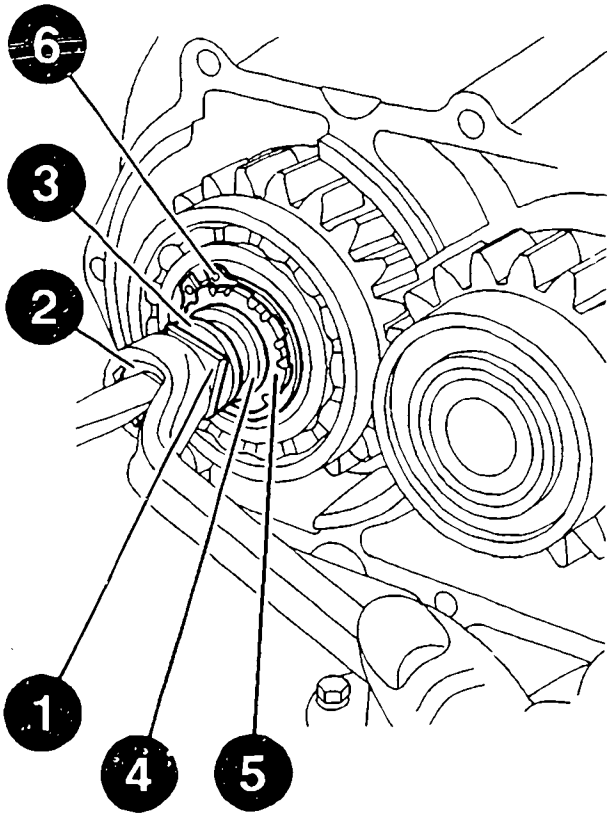


DISASSEMBLING 4-SPEED REUCTION GEAR (TYPE TF 0 001 6.. ...)

Bend over tab washer (1) of fastening nut (2) and unfasten nut.
Detach tab washer (1), square washer (3) and guide ring (4) from gear shaft (5).
Detach circlip (6).
Pull out reduction gear wheels together with deep-groove ball bearings.

Continue: III09/1 Fig.: III21/2

KMS00595



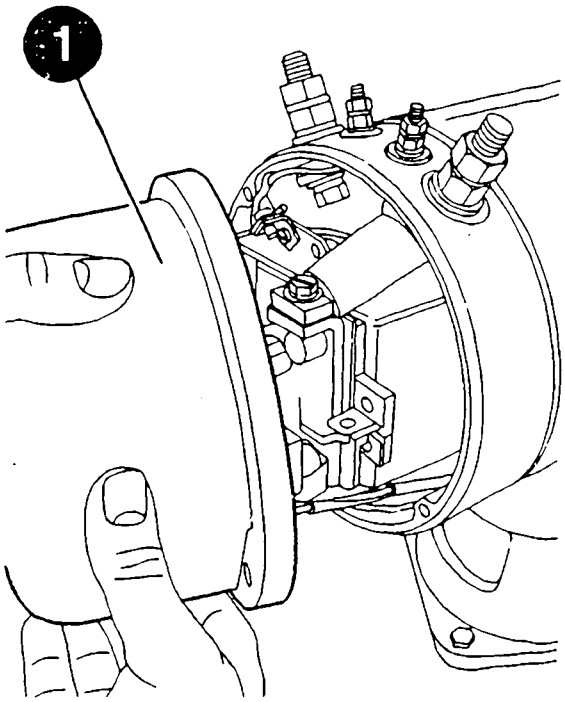
DISASSEMBLING COVER

Unfasten cover bolts.
Detach cover (1).

Detach O-ring if fitted.

Continue: III09/1 Fig.: III22/2

KMS00596

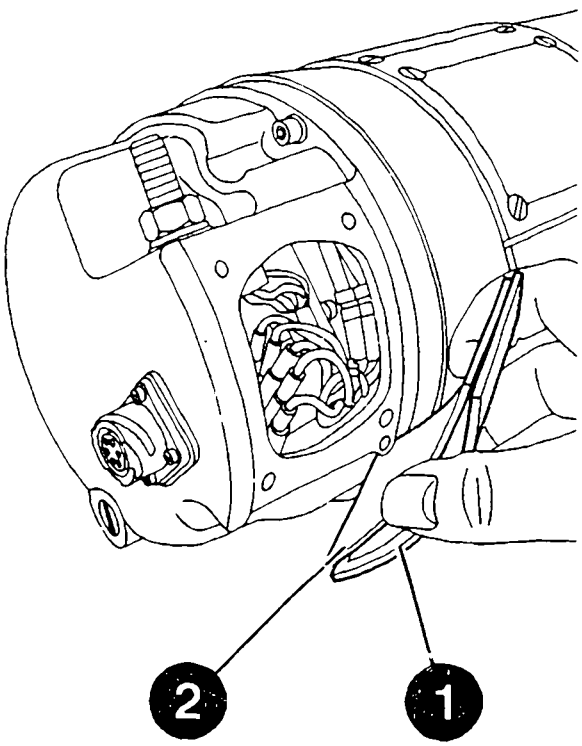


DISASSEMBLING COVER (TYPE TF 0 001 613 ...)

Unfasten cover plate bolts and detach cover plate (1) with sealing plate (2).

Continue: III24/1 Fig.: III23/2

KMS00597

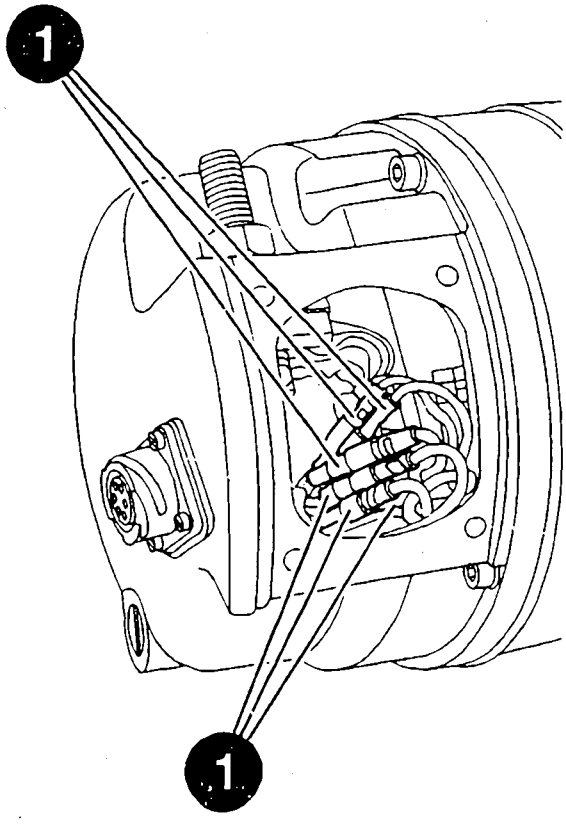


DISASSEMBLING COVER (TYPE TF 0 001 613 ...)

Detach cable connections (1) (plugs and jacks) of terminals 50, 50z, 48, 30 and terminal 30F to socket.

Continue: III25/1 Fig.: III24/2

KMS00598



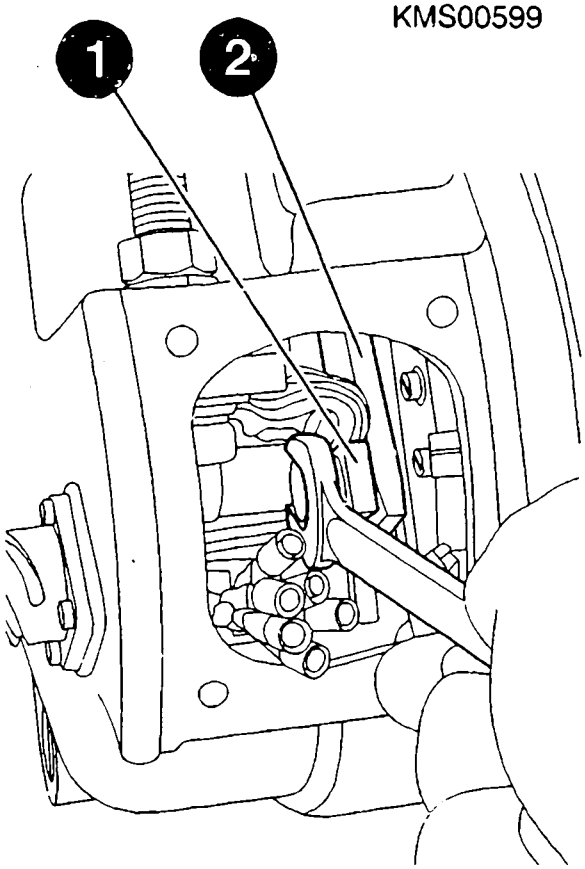
DISASSEMBLING COVER (TYPE TF 0 001 613 ...)

Unscrew ribbon cable (1) from contact rail (2) of starting-motor solenoid to term. 30.

NOTE: With type TF 0 001 613 001, connection term. 30 is designed as a high-current socket.

Continue: III26/1 Fig.: III25/2

KMS00599



DISASSEMBLING COVER
(TYPE TF 0 001 613 ...)

Type TF 0 001 613 003 only:

Completely disassemble connection term. 31.

ATTENTION: Note sequence of individual washers and insulating parts. Watch out for insulating sleeve in hole of commutator end shield.
Loosely re-assemble individual components immediately after dismantling.

Continue: III27/1

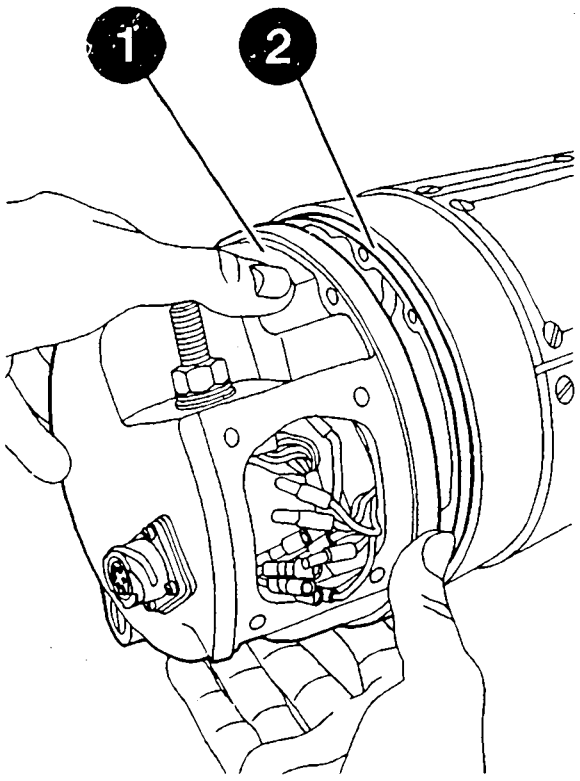
DISASSEMBLING COVER (TYPE TF 0 001 613 ...)

Unfasten cover bolts.
Detach cover (1).

Detach O-ring (2).

Continue: III09/1 Fig.: III27/2

KMS00600



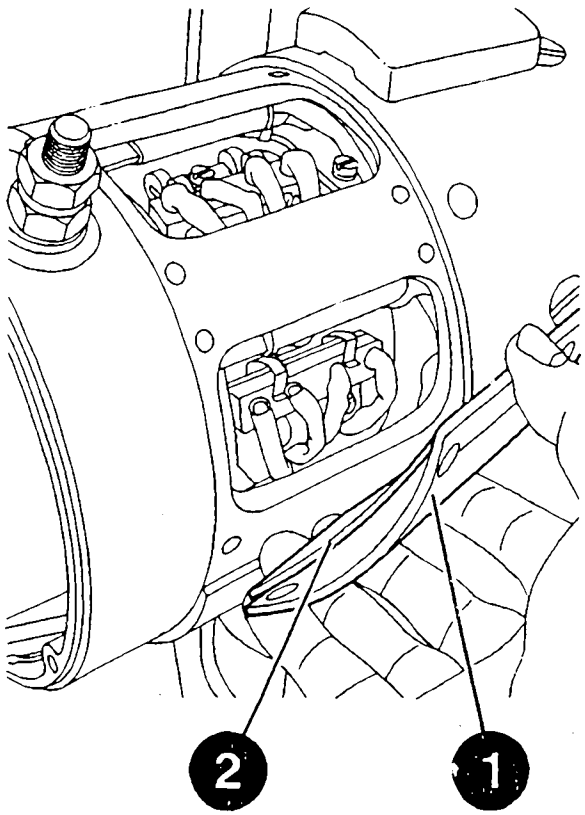
DISASSEMBLING COVER PLATES

Unfasten bolts of cover plates/ cover band (one or two-piece) of carbon brushes.

Detach cover plates (1) with sealing plates (2).

Continue: III09/1 Fig.: III28/2

KMS00601



DISASSEMBLING CARBON BRUSHES

Mark carbon brushes and respective fitting location.

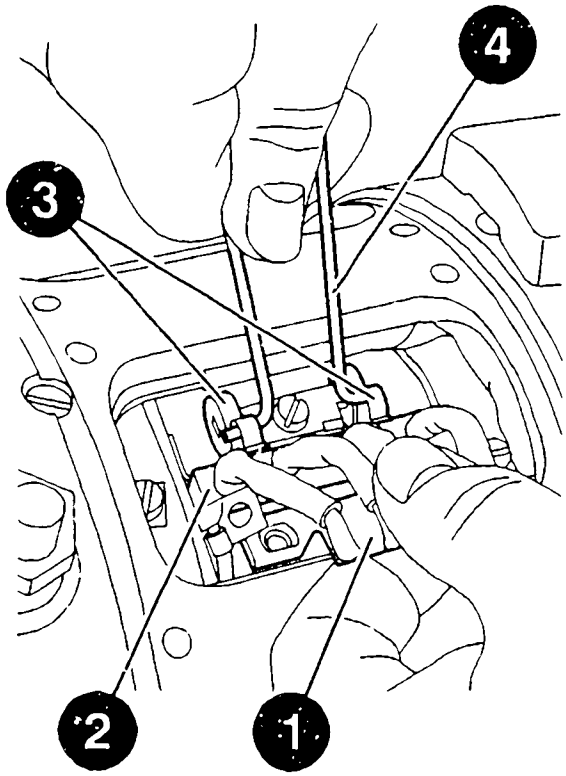
Unfasten connections (1) of carbon brushes (2).

Use improvised tool (4) to lift spiral springs (3) and pull carbon brushes (2) out of brush holder.

Tool: to be improvised

Continue: III09/1 Fig.: IV01/2

KMS00602

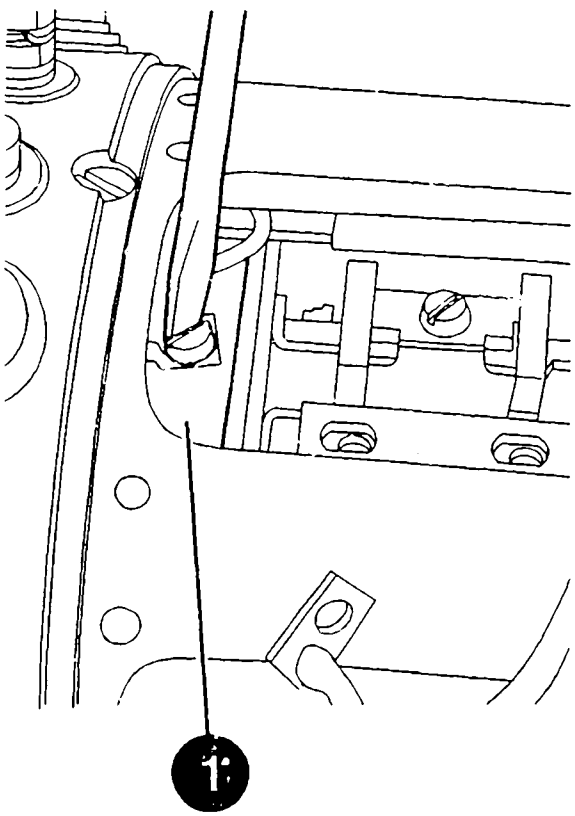


DISASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Detach all connections and unions at connecting ring (1) of excitation winding.

Continue: IV03/1 Fig.: IV02/2

KMS00603



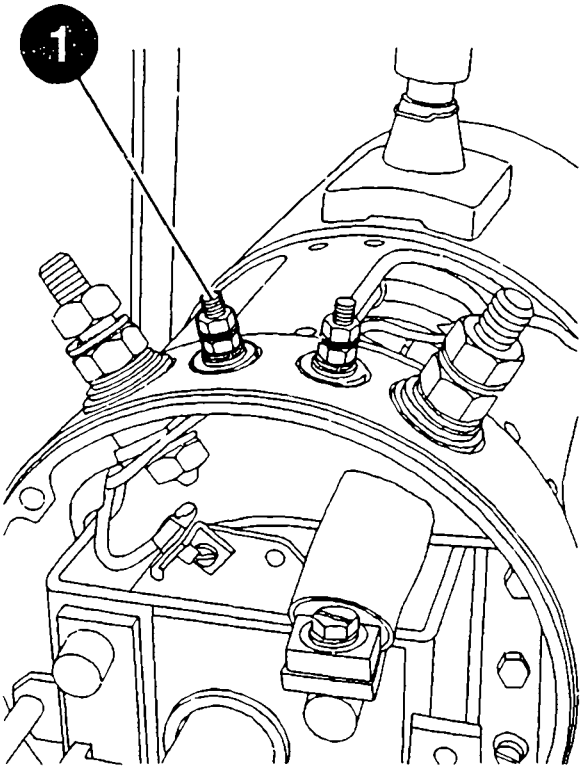
DISASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Completely disassemble connection term. 50 (1).

ATTENTION: Note sequence of individual washers and insulating parts.
Watch out for insulating sleeve in hole in commutator end shield.
Loosely re-assemble individual components immediately after dismantling.

Continue: IV04/1 Fig.: IV03/2

KMS00604



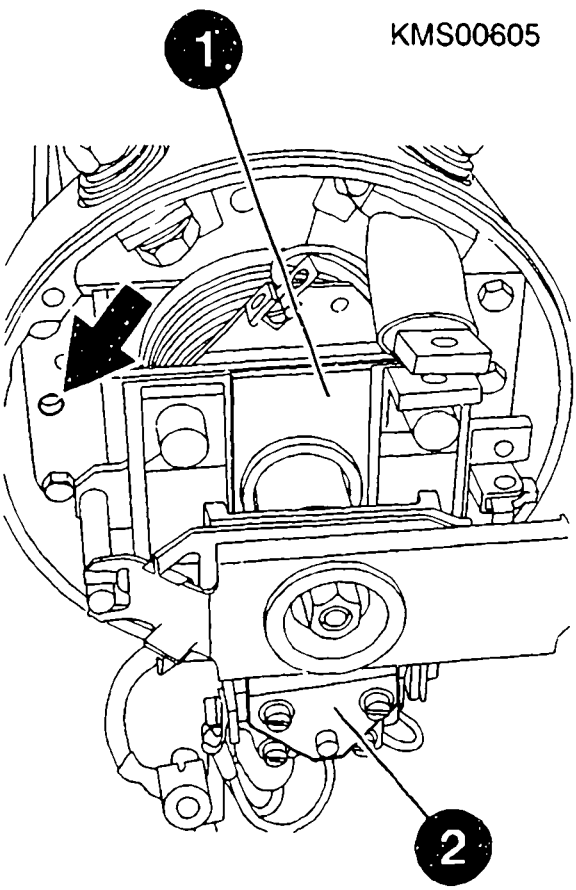
DISASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Detach all other connections at starting-motor solenoid (1) and control relay (2).

Versions with thermoswitch only:

Unfasten one bolt of starting-motor solenoid (arrow) and detach cable clamp with cable (already dismantled in Fig.).

Continue: IV05/1 Fig.: IV04/2



DISASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

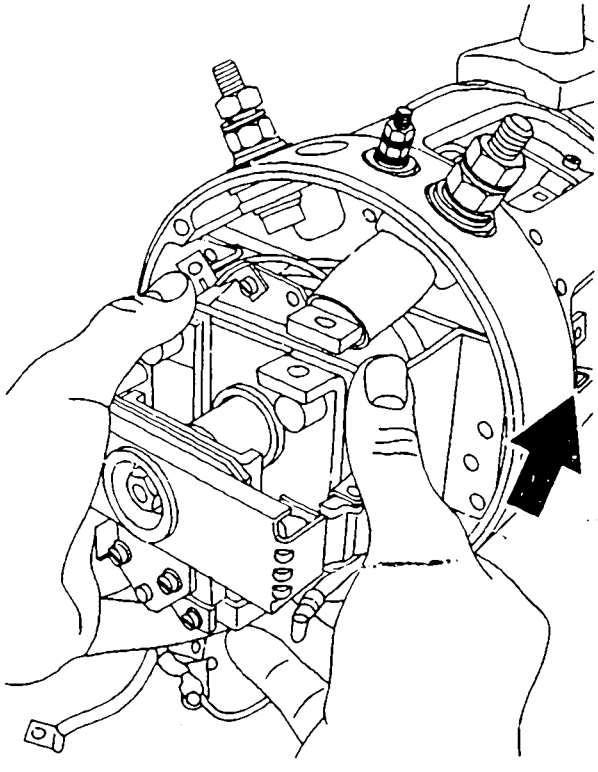
Unfasten bolts of starting-motor solenoid and detach starting-motor solenoid together with control relay.

ATTENTION: DANGER OF INJURY
Engagement rod is subject to spring pretension and springs out of armature on disassembling starting-motor solenoid.

NOTE: Take insulating tubing (arrow) of slotted-head bolts out of commutator end shield.

Continue: IV06/1 Fig.: IV05/2

KMS00606

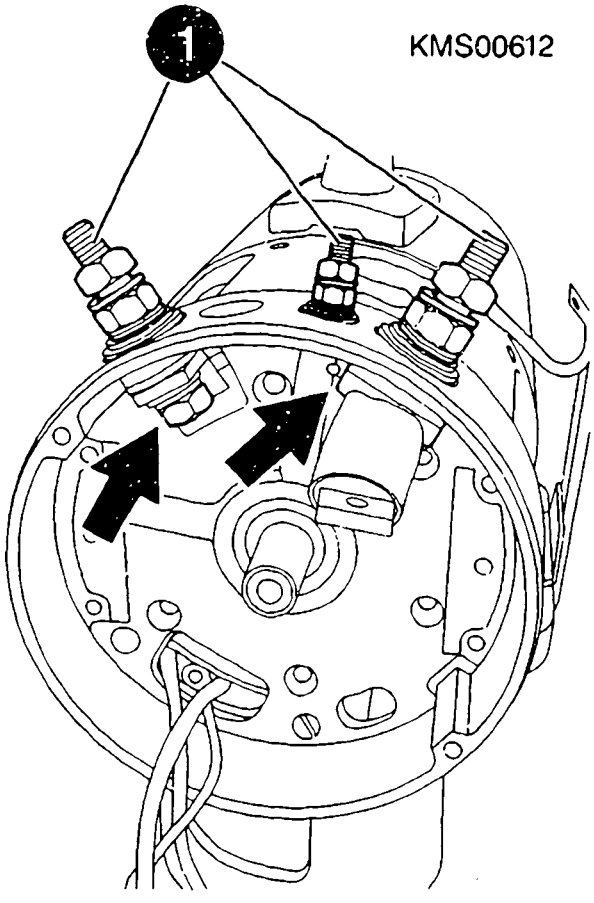


DISASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Completely disassemble connections term. 30, term. 31 and term. 48 (1).
NOTE: For term. 30 and term. 31, only unfasten nut inside commutator end shield (arrows).

ATTENTION: Note sequence of individual washers and insulating parts.
Watch out for insulating sleeve in hole in commutator end shield.
Loosely re-assemble individual components immediately after dismantling.

Continue: III09/2 Fig.: IV06/2



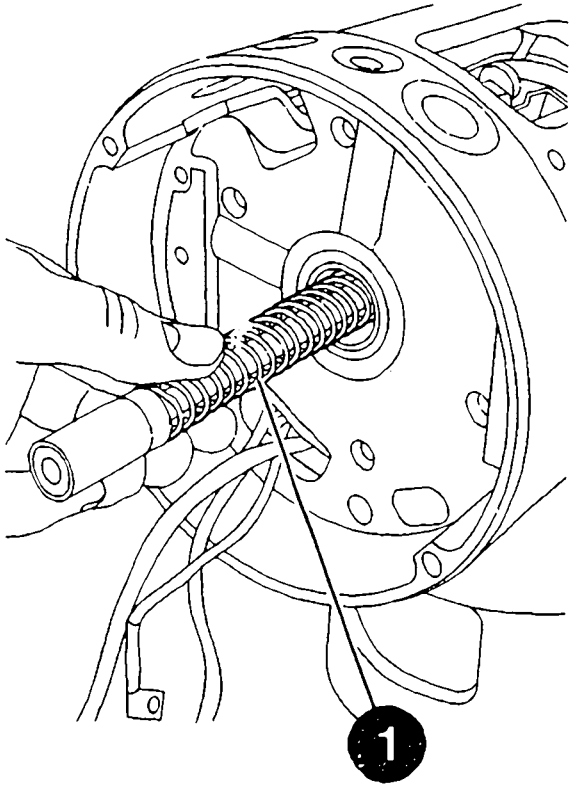
DISASSEMBLING ENGAGEMENT ROD

Pull engagement rod (1) on commutator end out of armature.

NOTE: Be sure to remove feather key on drive end of engagement rod beforehand.

Continue: III09/2 Fig.: IV07/2

KMS00613



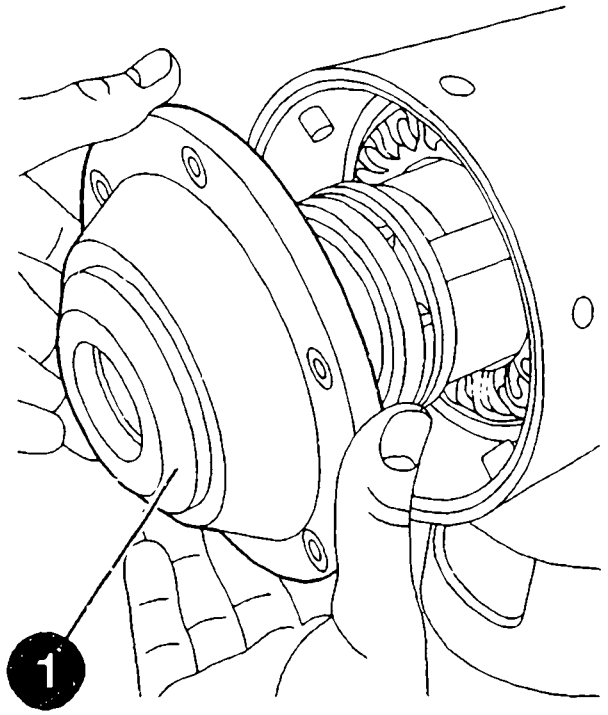
DISASSEMBLING DRIVE END SHIELD

Unfasten bolts of drive end shield and detach drive end shield (1).

NOTE: If drive end shield has seized, it can be detached from the stator housing by tapping carefully with a plastic-headed hammer.

Continue: III09/2 Fig.: IV08/2

KMS00614



DISASSEMBLING ARMATURE

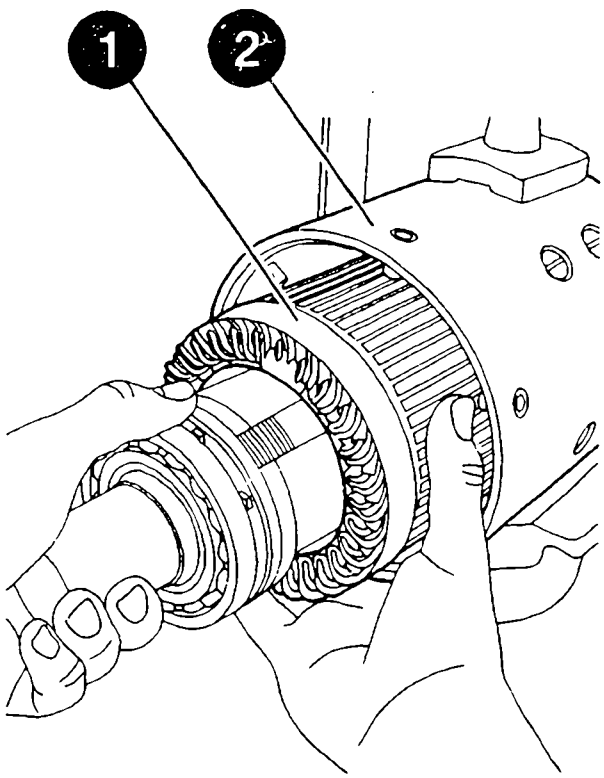
Pull armature (1) complete with multi-plate clutch out of stator housing (2) to drive end shield side.

Watch out for shims of armature shaft.

ATTENTION: Take care not to damage excitation winding.

Continue: IV10/1 Fig.: IV09/2

KMS00617



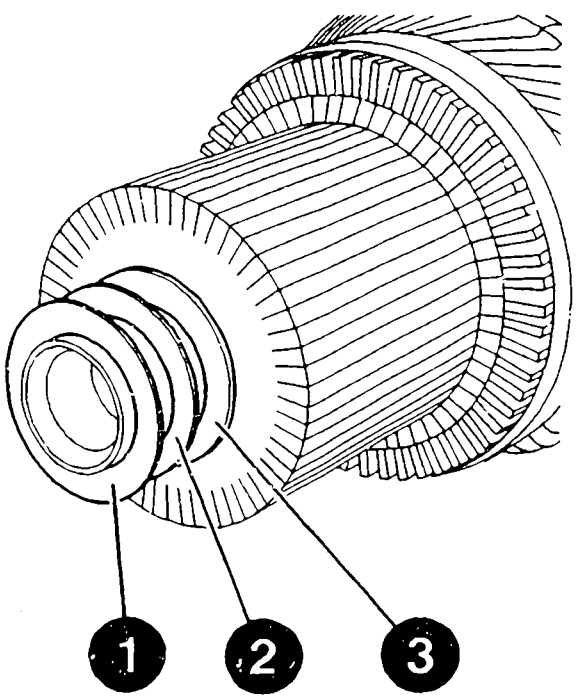
DISASSEMBLING ARMATURE

Detach shim (1), stop disc (2) and shim (3) (steel shim) from armature shaft.

NOTE: Pay attention to sequence.

Continue: III09/2 Fig.: IV10/2

KMS00616



DISASSEMBLING COMMUTATOR END SHIELD

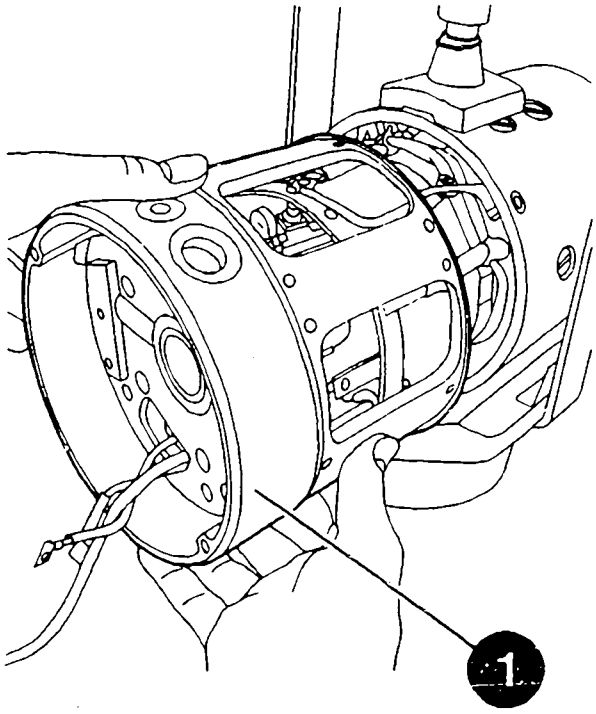
Unfasten caulked bolts and take insulating tubing out of commutator end shield.

Pull off commutator end shield (1).

ATTENTION: Take care not to damage insulation of protruding connections.

Continue: III09/2 Fig.: IV11/2

KMS00615



DISASSEMBLING DEEP-GROOVE BALL BEARING OF INTERMEDIATE BEARING

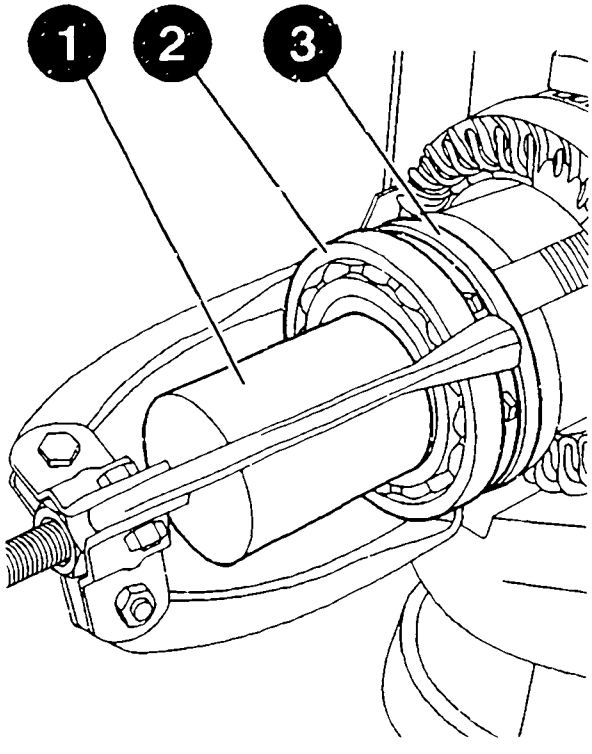
Clamp armature in clamping support. Slip centering sleeve (1) onto gear shaft.

Use puller to pull deep-groove ball bearing (2) off inner race of intermediate bearing (3).

Clamping support:	0 986 619 362
Centering sleeve:	to be improvised
Puller:	comm. avail.

Continue: III09/2 Fig.: IV12/2

KMS00618



DISASSEMBLING MULTI-PLATE CLUTCH

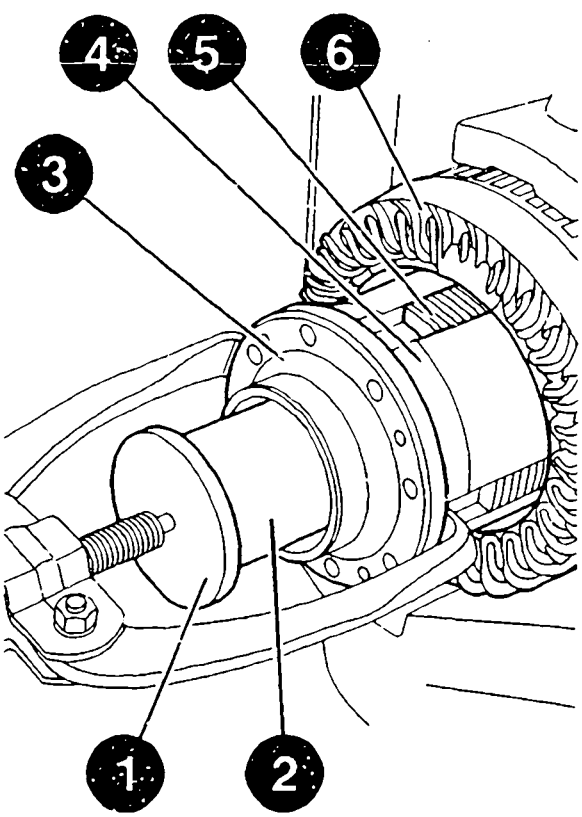
Unfasten bolts of intermediate bearing
(already dismantled in Fig.).

Insert thrust piece (1) in gear shaft (2).
Use puller to pull intermediate bearing (3) off clutch housing (4).
Watch out for spring pins in intermediate bearing.
Pull multi-plate clutch assembly (5) out of armature (6).

Thrust piece: to be improvised
Puller: comm. avail.

Continue: III09/2 Fig.: IV13/2

KMS00619



COMPONENT CLEANING

Component cleaning:
Armature, windings, plain bearings, relays and the shaft ends of the multi-plate clutch are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agent.

Other components such as bolts, armature shafts, deep-groove ball bearing and drive end shield can be washed out in a commercial cleaning agent which is not readily flammable. Take care not to inhale vapors.

Continue: IV14/2

COMPONENT CLEANING

Danger of fire: Take care to avoid naked flames and sparking.

ATTENTION:
Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Continue: IV15/1

COMPONENT CLEANING

Always heed the following safety regulations:

* German Order governing the use of flammable liquids (VbF).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for the handling of chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: IV15/2

COMPONENT CLEANING

Outside Germany, pay attention to appropriate local regulations.

Skin protection:
To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

TESTING, REPAIR TABLE

Continue: IV16/2

TESTING, REPAIR TABLE

Continue: I01/1

CHECKING/REPLACING PINION

Check all pinions for running marks and chipping.
Replace if necessary.

NOTE: If necessary, pinions have to be replaced complete with cylindrical roller bearings in the case of 4-speed reduction gears.

Continue: IV16/1

CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

GENERAL:
Cylindrical roller bearings, supporting plates and radial shaft oil seals in drive/reduction gear end shield are only renewed if necessary.

TF-STARTER:
Needle bearing in drive end shield is likewise only replaced if necessary.

Continue: IV18/1

CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

TE-STARTER:
The bushings of the reduction gear shaft in the reduction gear and drive end shield can only be replaced at BOSCH factories as calibration is required.

STARTER WITH 4-SPEED REDUCTION GEAR:
If necessary, pinions must be replaced complete with cylindrical roller bearings.

Continue: IV18/2

CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

Type TF 0 001 613 ... only

Removing radial shaft oil seal in cover of reduction gear end shield

Use suitable tool to prise radial shaft oil seal out of cover.

ATTENTION: Take care not to damage seat of radial shaft oil seal.

Continue: IV19/1

CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

Type TF 0 001 613 ... only

Inserting radial shaft oil seal in cover of reduction gear end shield

Insert radial shaft oil seal by hand in cover.

Continue: IV20/1

CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

Removing cylindrical roller bearing in drive/reduction gear end shield

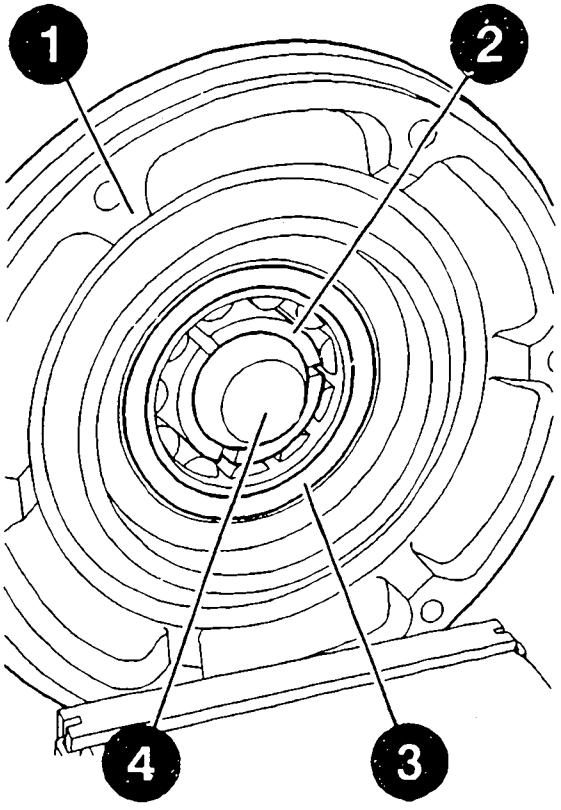
Clamp drive end shield (1) in vice. Insert three-part thrust piece (2) from outside in cylindrical roller bearing (3) such that gripping edges of thrust piece are positioned between radial shaft oil seal and cylindrical roller bearing.

Insert mandrel (4) in thrust piece.

Pressing-out tool: to be improvised

Continue: IV21/1 Fig.: IV20/2

KMS00620



CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

Removing cylindrical roller bearing in drive/reduction gear end shield

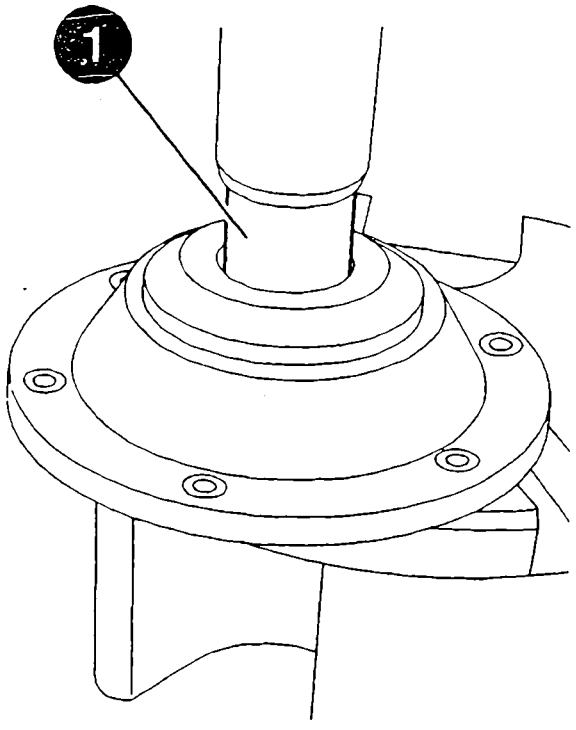
Press out cylindrical roller bearing with pressing-out tool (1) on mandrel press.

Take supporting plate out of drive end shield and use suitable tool to prise radial shaft oil seal out of drive end shield.

Mandrel press: comm. avail.

Continue: IV22/1 Fig.: IV21/2

KMS00621



CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

Installing cylindrical roller bearing in drive/reduction gear end shield

ATTENTION: On installation in reduction gear end shield, cylindrical roller bearing is to be pressed in such that pressing-in mandrel presses against NON-LABELLED side of cylindrical roller bearing.

Continue: IV23/1

CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

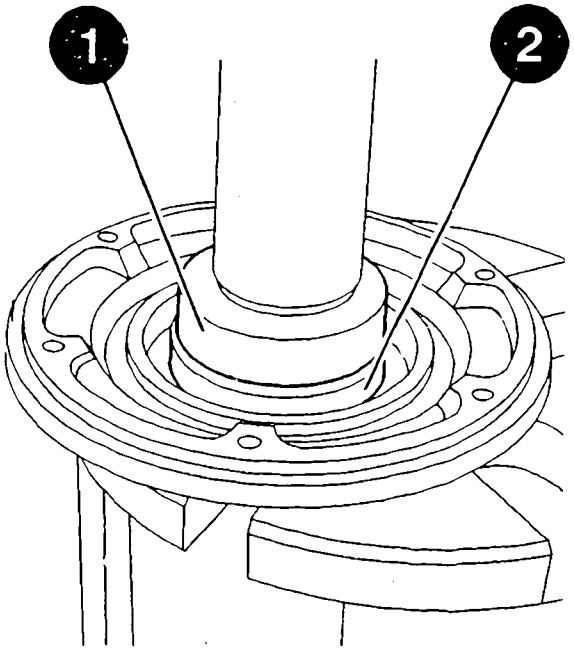
Installing cylindrical roller bearing in drive/reduction gear end shield

Grease components before installing.
Use pressing-in mandrel (1) to press home radial shaft oil seal.
Insert supporting plate.
Press in cylindrical roller bearing (2) with pressing-in mandrel (1) on mandrel press.

Pressing-in mandrel: to be improvised
Grease VS 10832: 5 932 240 000

Continue: IV24/1 Fig.: IV23/2

KMS00622



CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

Removing needle bearing in drive end shield (starters with reduction gear only)

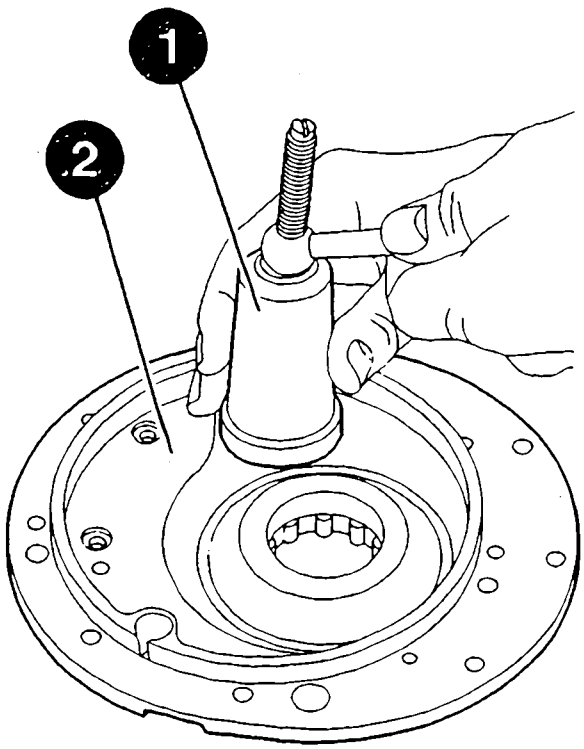
Disassemble bearing end plate of needle bearing (already dismantled in Fig.).

Use puller (1) to pull needle bearing out of drive end shield (2).

Puller: 0 986 619 233

Continue: IV25/1 Fig.: IV24/2

KMS00623



CHECKING/REPAIRING DRIVE AND REDUCTION GEAR END SHIELD

Installing needle bearing in drive end shield (starters with reduction gear only)

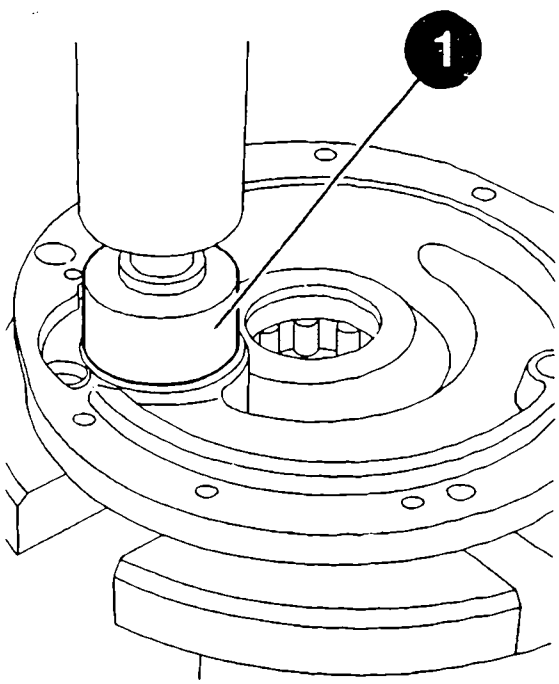
Grease new needle bearing before installing.

Press in needle bearing with pressing-in mandrel (1) on mandrel press.
Fit bearing end plate and then caulk bolts.

Pressing-in mandrel: to be improvised
Grease VS 10832: 5 932 240 000

Continue: IV16/1 Fig.: IV25/2

KMS00624



CHECKING/REPAIRING COMMUTATOR END SHIELD

Replace bushing in commutator end shield if damaged or worn.

NOTE: If no smoothing mandrel is available for treating the new bushing, bushing can only be replaced at BOSCH factories.

Continue: IV27/1

CHECKING/REPAIRING COMMUTATOR END SHIELD

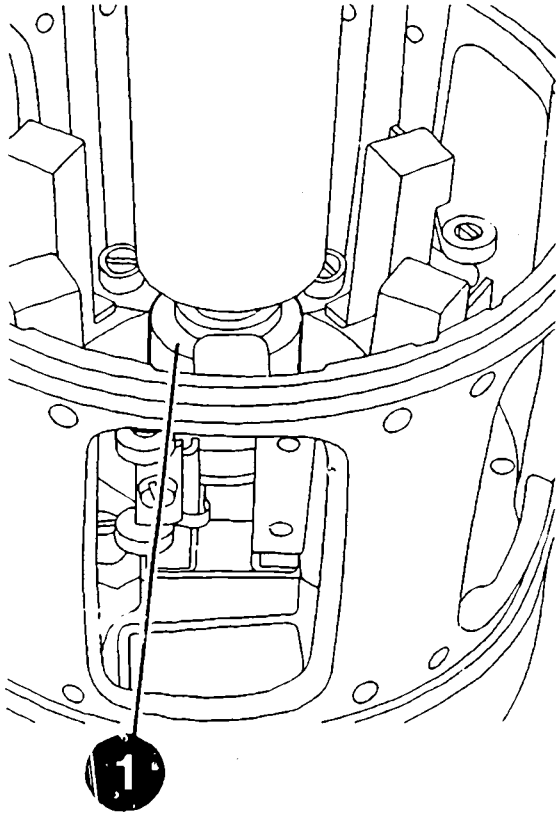
Removing bushing:

Uncaulk grub screw and screw it out. Press out bushing with pressing-out mandrel (1) on mandrel press.

Mandrel press:	comm. avail.
Pressing-out mandrel	to be improvised

Continue: IV28/1 Fig.: IV27/2

KMS00625



CHECKING/REPAIRING COMMUTATOR END SHIELD

Installing bushing:

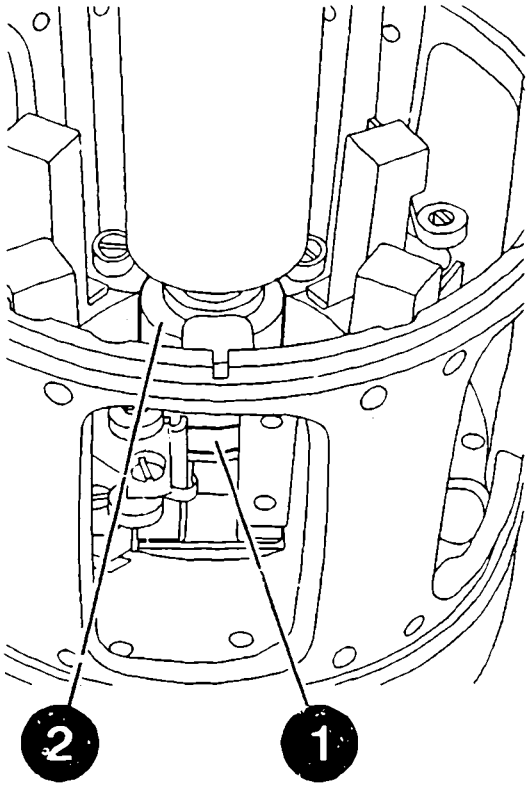
Soak new bushing for 8 hours in suitable oil before installing.

Press in bushing (1) with pressing-in mandrel (2) on mandrel press such that it is flush and treat with smoothing mandrel.
ATTENTION: Take care not to jam in lubricating felt and re-lubricate via oil hole.

Pressing-in mandrel:	to be improvised
Smoothing mandrel	to be improvised
Oil VS 13834-01:	5 962 260 6..

Continue: V01/1 Fig.: IV28/2

KMS00626



CHECKING/REPAIRING COMMUTATOR END SHIELD

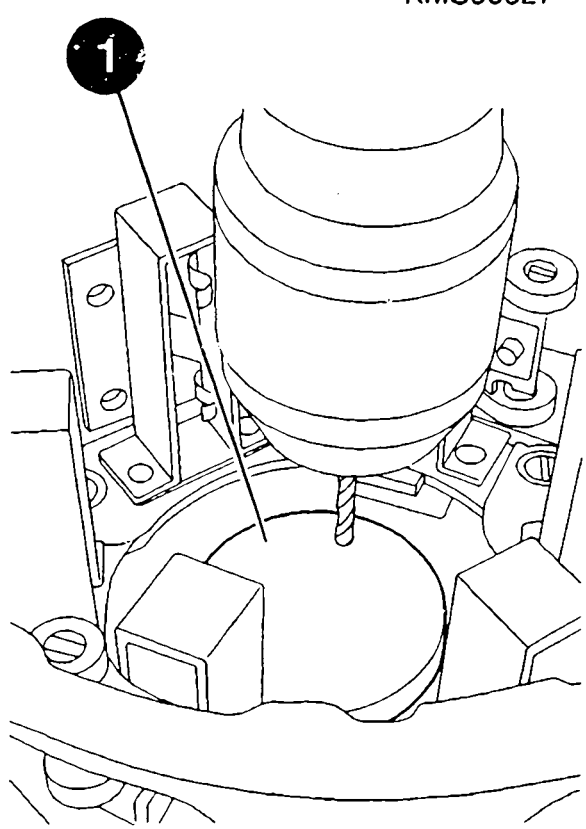
Installing bushing (continued):

Insert drill jig (1) in bushing and drill a 3.2 mm dia. hole offset from existing hole. Take out drill jig and cut M4 thread in hole. Screw in and caulk grub screw.
ATTENTION: Grub screw must not project.
Blow out commutator end shield with compressed air.

Drill jig: to be improvised

Continue: IV16/1 Fig.: V01/2

KMS00627



CHECKING/REPLACING BRUSH HOLDER

Renew damaged or scorched spiral springs.

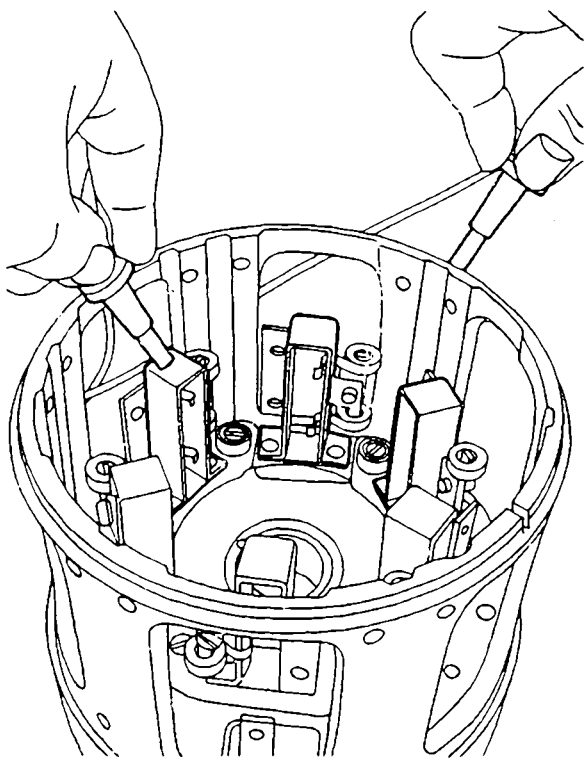
Use tester and test prods to check cartridge-type brush holder for short to ground.

Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 114
Test voltage Ground short test:	80 V*

* = AC

Continue: IV16/1 Fig.: V02/2

KMS00628



CHECKING/REPLACING CARBON BRUSHES

Check tightness of connections.
Check bearing surfaces for scoring and chipping.

Replace carbon brushes if minimum dimension has been reached.

Carbon brush as-new dimension: 26,5 mm
Min. carbon brush dimension: 18 mm

Continue: IV16/1

CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

It is advisable to completely replace scorched or damaged control relays and starting-motor solenoids.

Control relay and starting-motor solenoid can be replaced separately.
NOTE: Individual components can also be replaced. This procedure is however not described here.

Always make use of the parts given in the spare parts list.

Continue: V04/1

CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

Use contact file to clean all contacts.

Continue: V05/1

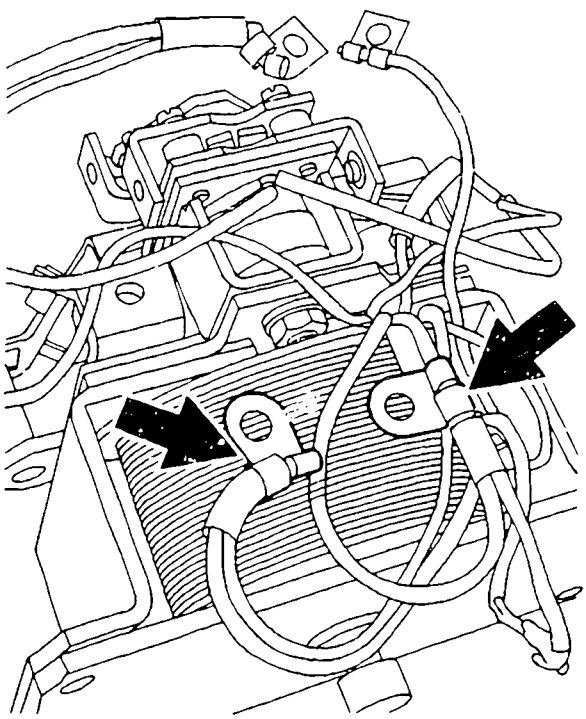
CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

NOTE: Pull-in winding and opposing winding are connected in parallel.

Measuring the resistance of the pull-in and opposing winding involves unsoldering the connections at the cable lugs (arrows) and measuring the windings individually.

Continue: V06/1 Fig.: V05/2

KMS00629



CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

Checking pull-in winding

Heed note.
Use alternator tester to check resistance between black and yellow wire (large cross-section).

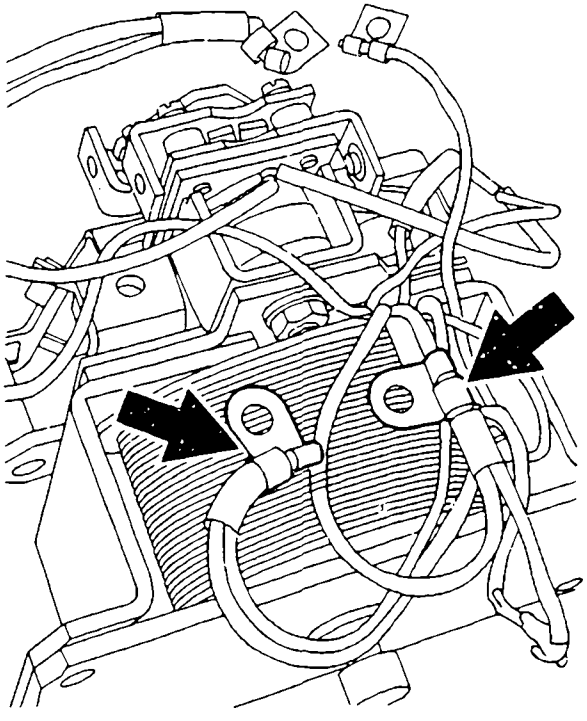
Resistances of the various types of starting-motor solenoid:

- Refer to the following table -

Alternator tester: 0 684 201 200

Continue: V07/1 Fig.: V06/2

KMS00629



CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

PULL-IN WINDING RESISTANCES

Starter type	Power	Resistance
TB 24 V	10 kW	0.15...0.17 ohms
TB 24 V	15 kW	0.10...0.12 ohms
TB 24 V	18 kW	0.09...0.11 ohms
TB 32 V	18 kW	0.18...0.20 ohms
TB 36 V	20 kW	0.32...0.34 ohms
TF 24 V	10 kW	0.61...0.65 ohms
TF 24 V	15 kW	0.14...0.16 ohms
TF 24 V	18 kW	0.10...0.12 ohms

Continue: V07/2

CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

PULL-IN WINDING RESISTANCES

Starter type	Power	Resistance
TF 32 V	18 kW	0.32...0.34 ohms
TF 36 V	20 kW	0.32...0.34 ohms
TE 24 V	10 kW	0.61...0.65 ohms
TE 24 V	15 kW	0.14...0.16 ohms
TE 32 V	18 kW	0.18...0.20 ohms
TE 32 V	20 kW	0.18...0.20 ohms
TE 36 V	20 kW	0.32...0.34 ohms

Continue: V08/1

CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

Checking opposing winding

Heed note.
Use alternator tester to check resistance between black and yellow wire (small cross-section).

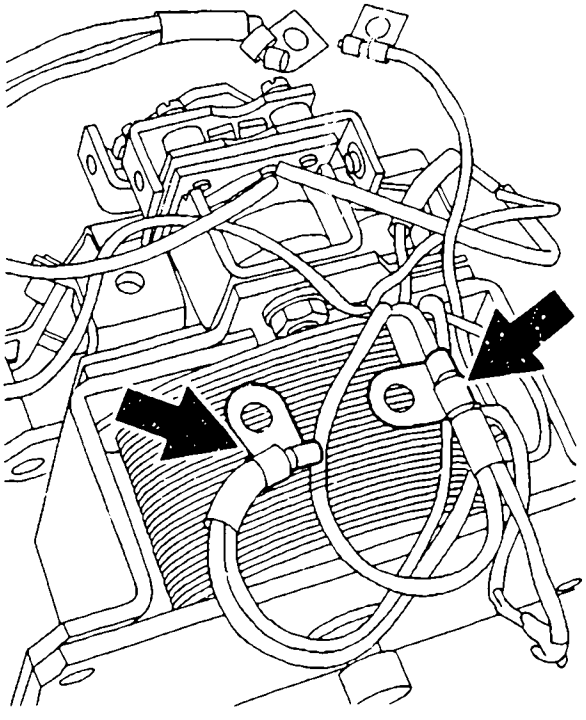
Resistances of the various types of starting-motor solenoid:

- Refer to following table -

Alternator tester: 0 684 201 200

Continue: V09/1 Fig.: V08/2

KMS00629



CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

OPPOSING WINDING RESISTANCES

Starter type	Power	Resistance
TB 24 V	10 kW	0.61...0.65 ohms
TB 24 V	15 kW	0.56...0.60 ohms
TB 24 V	18 kW	0.39...0.41 ohms
TB 32 V	18 kW	0.80...0.84 ohms
TB 36 V	20 kW	0.56...0.60 ohms
TF 24 V	10 kW	0.98...1.02 ohms
TF 24 V	15 kW	0.51...0.55 ohms
TF 24 V	18 kW	0.29...0.31 ohms

Continue: V09/2

CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

OPPOSING WINDING RESISTANCES

Starter type	Power	Resistance
TF 32 V	18 kW	0.80...0.84 ohms
TF 36 V	20 kW	0.56...0.60 ohms
TE 24 V	10 kW	0.98...1.02 ohms
TE 24 V	15 kW	0.51...0.55 ohms
TE 32 V	18 kW	0.80...0.84 ohms
TE 32 V	20 kW	0.80...0.84 ohms
TE 36 V	20 kW	0.56...0.60 ohms

Continue: V10/1

CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

Checking holding winding

Use alternator tester to check resistance between blue and red wire.

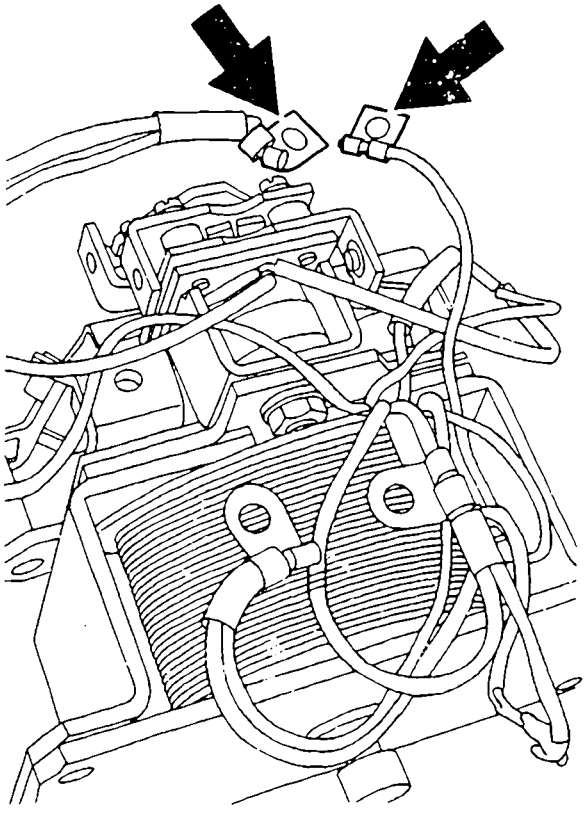
Resistances of the various types of starting-motor solenoid:

- Refer to following table -

Alternator tester: 0 684 201 200

Continue: V11/1 Fig.: V10/2

KMS00630



CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

HOLDING WINDING RESISTANCES

Starter type	Power	Resistance
TB 24 V	10 kW	1.70...1.90 ohms
TB 24 V	15 kW	1.70...1.90 ohms
TB 24 V	18 kW	1.70...1.90 ohms
TB 32 V	18 kW	2.65...2.85 ohms
TB 36 V	20 kW	2.65...2.85 ohms
TF 24 V	10 kW	1.30...1.50 ohms
TF 24 V	15 kW	1.30...1.50 ohms
TF 24 V	18 kW	1.30...1.50 ohms

Continue: V11/2

CHECKING/REPAIRING CONTROL RELAY AND STARTING-MOTOR SOLENOID

HOLDING WINDING RESISTANCES

Starter type	Power	Resistance
TF 32 V	18 kW	2.65...2.85 ohms
TF 36 V	20 kW	2.65...2.85 ohms
TE 24 V	10 kW	1.30...1.50 ohms
TE 24 V	15 kW	1.30...1.50 ohms
TE 32 V	18 kW	2.65...2.85 ohms
TE 32 V	20 kW	2.65...2.85 ohms
TE 36 V	20 kW	2.65...2.85 ohms

Continue: IV16/1

ADJUSTING CONTROL RELAY AND STARTING-MOTOR SOLENOID

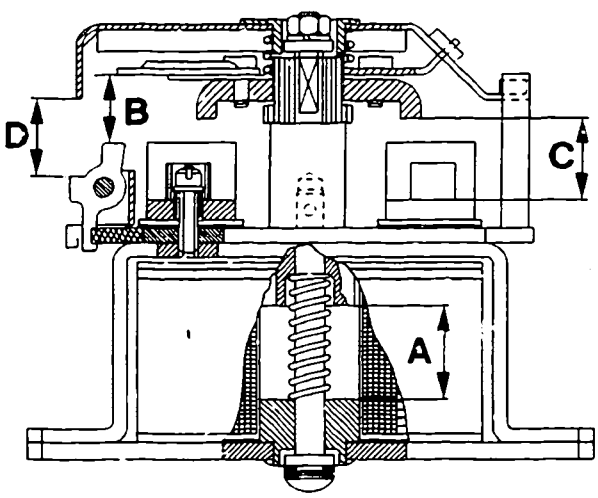
DIMENSION A = STROKE OF MAGNETIC CORE

Set value: 24,8...25,2 mm

Adjusting:
- Knock out spring pin
- Adjust dimension by turning cap
- Knock in spring pin

Continue: V13/1 Fig.: V12/2

KMS00572



ADJUSTING CONTROL RELAY AND STARTING-MOTOR SOLENOID

DIMENSION B = LOCKING/ENGAGING LEVER GAP

Set value: 19,5...19,8 mm

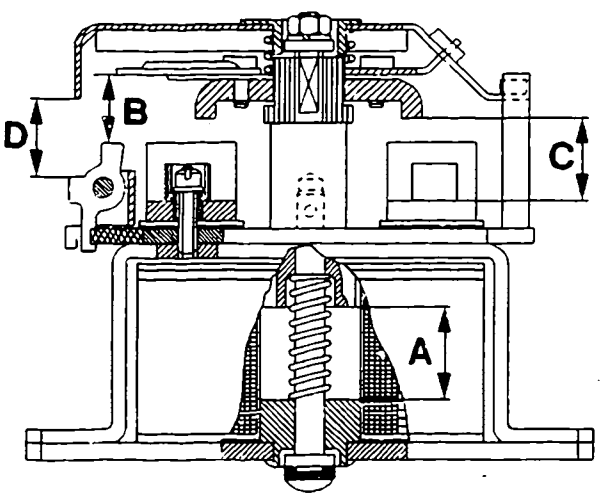
Adjusting:

- Unfasten hexagon nut, detach tripping lever
  ATTENTION: DANGER OF INJURY
  Tripping lever is pretensioned by spring
- Adjust by way of shims

Tightening torque, hexagon nut: 10...15 Nm

Continue: V14/1 Fig.: V13/2

KMS00572



ADJUSTING CONTROL RELAY AND STARTING-MOTOR SOLENOID

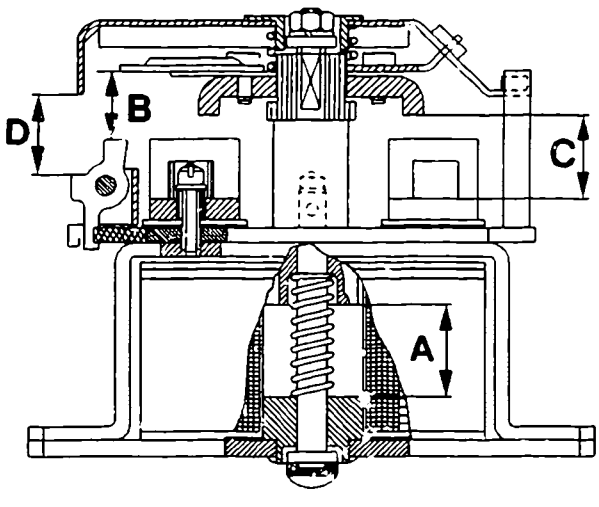
DIMENSION C = GAP BETWEEN BUSBAR AND CONTACT BRACKET

Set value: 22,1...22,7 mm

Reference dimension; no adjustment possible

Continue: V15/1 Fig.: V14/2

KMS00572



ADJUSTING CONTROL RELAY AND STARTING-MOTOR SOLENOID

DIMENSION D = TRIPPING/ENGAGING LEVER GAP

Set value: 23,0...23,5 mm

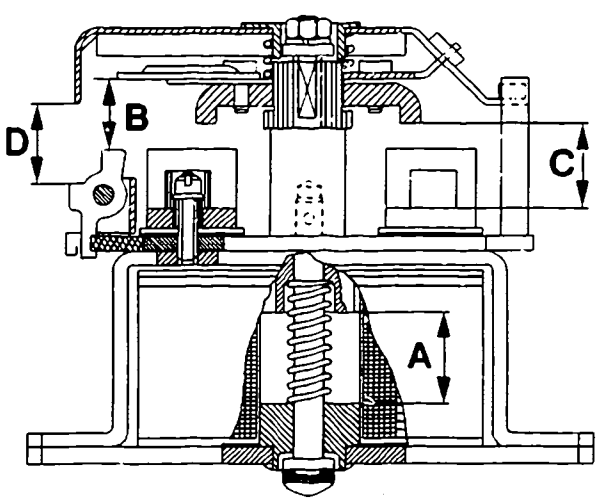
Adjusting:

- Unfasten hexagon nut, detach tripping lever
  ATTENTION: DANGER OF INJURY
  Tripping lever is pretensioned by spring
- Adjust by way of shims

Tightening torque, hexagon nut: 10...15 Nm

Continue: IV16/1 Fig.: V15/2

KMS00572



CHECKING/REPAIRING MULTI-PLATE CLUTCH

NOTE: Threaded ring is renewed after disassembly.

Disassembling multi-plate clutch:

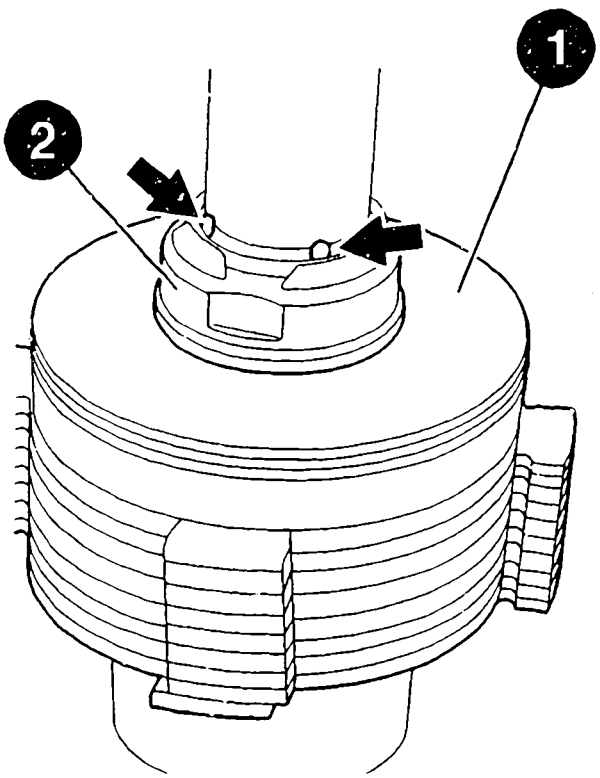
Clamp clamping pin in vice and slip on clutch (1). File off threaded ring (2) in caulked areas (arrows) on non-hardened part of ring.

ATTENTION: Take care not to damage thread of gear shaft.

Clamping pin: to be improvised

Continue: V17/1 Fig.: V16/2

KMS00633



CHECKING/REPAIRING MULTI-PLATE CLUTCH

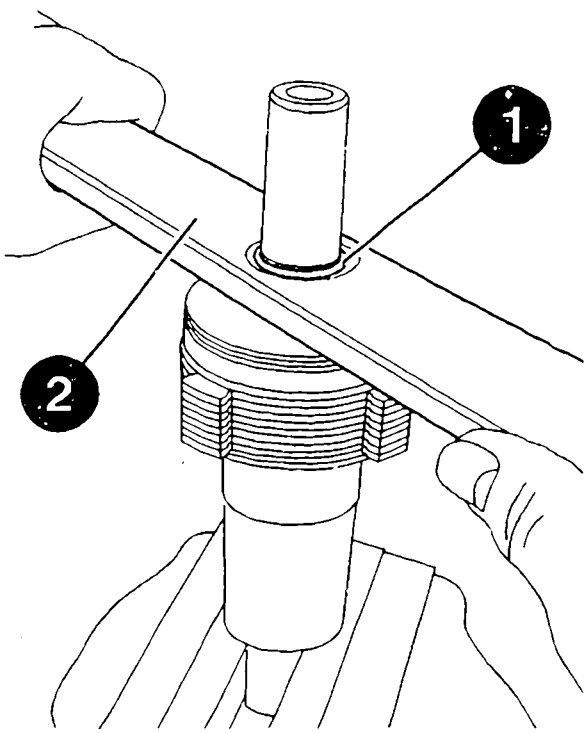
Disassembling multi-plate clutch (continued):

Use assembly wrench (2) to unfasten threaded ring (1).
ATTENTION: Right-hand or left-hand thread. Detach components, clean and perform visual inspection.
NOTE: Pay attention to sequence of components.

Assembly wrench: to be improvised

Continue: V18/1 Fig.: V17/2

KMS00634



CHECKING/REPAIRING MULTI-PLATE CLUTCH

Assembling multi-plate clutch:

NOTE: Apply small quantity of grease to all clutch components.

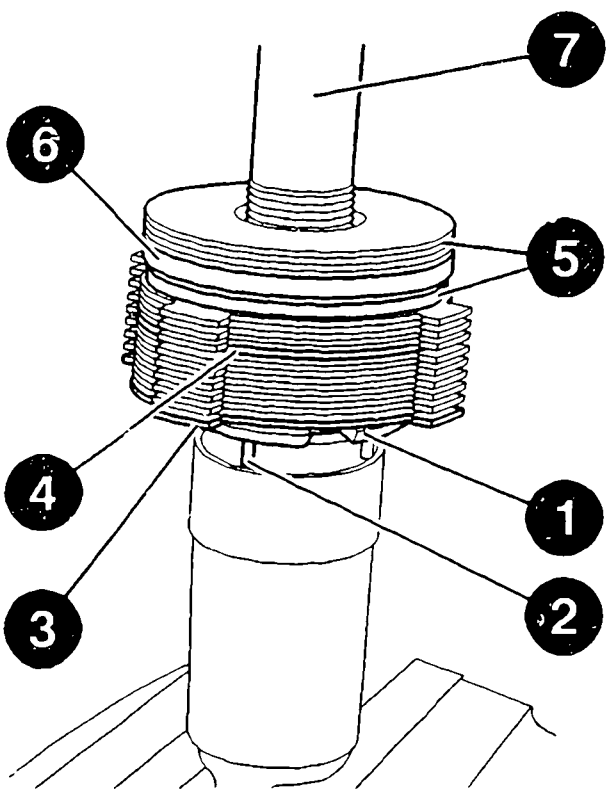
Fit clutch half (1) with spring pins (2), clutch plates (3) and (4), shims (5) and thrust ring (6) on gear shaft (7).

ATTENTION: Note correct assembly sequence of components.

Grease Ft2 v 3: 5 700 082 0..

Continue: V19/1 Fig.: V18/2

KMS00635



CHECKING/REPAIRING MULTI-PLATE CLUTCH

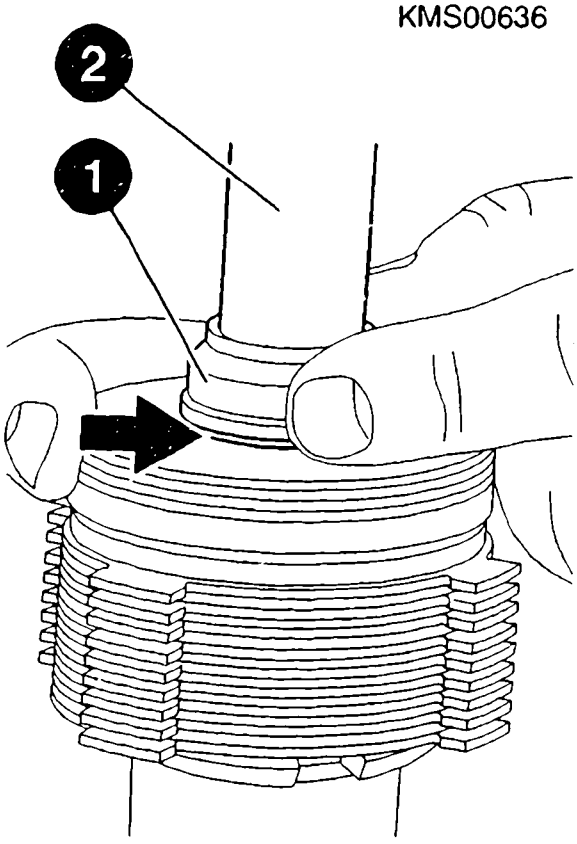
Assembling multi-plate clutch (continued):

Screw threaded ring (1) onto gear shaft (2).
ATTENTION: Top washer (arrow) must not become jammed under threaded ring.
Use assembly wrench to tighten threaded ring but do not caulk as yet.

Assembly wrench: to be improvised

Continue: V20/1 Fig.: V19/2

KMS00636



CHECKING/REPAIRING MULTI-PLATE CLUTCH

Checking overload protection

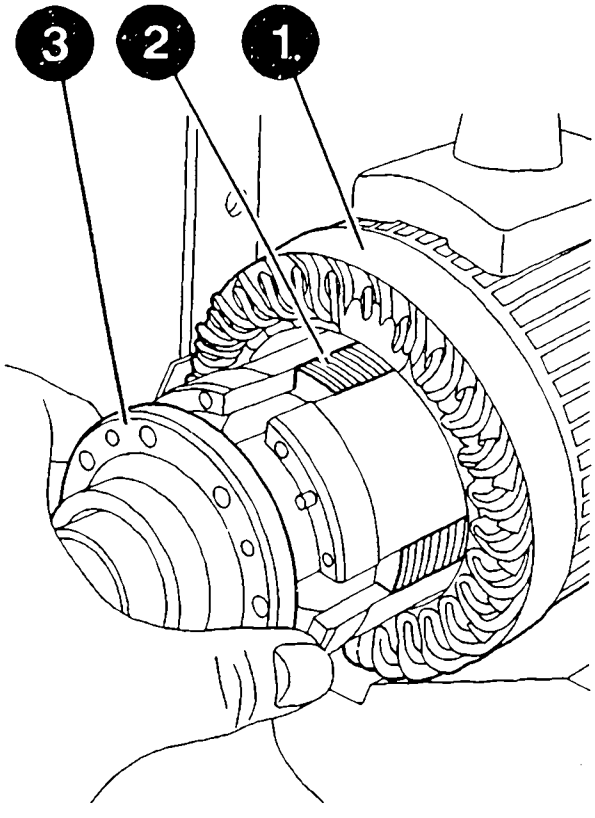
ATTENTION: Armature may be damaged.
Never re-use.

Clamp old armature (1) in clamping support. Insert clutch (2) in clutch housing and fit intermediate bearing (3) with old bolts.
Use torque wrench.

Clamping support:	0 986 619 362
Torque wrench:	comm. avail.
Tightening torque:	7...8 Nm

Continue: V21/1 Fig.: V20/2

KMS00637



CHECKING/REPAIRING MULTI-PLATE CLUTCH

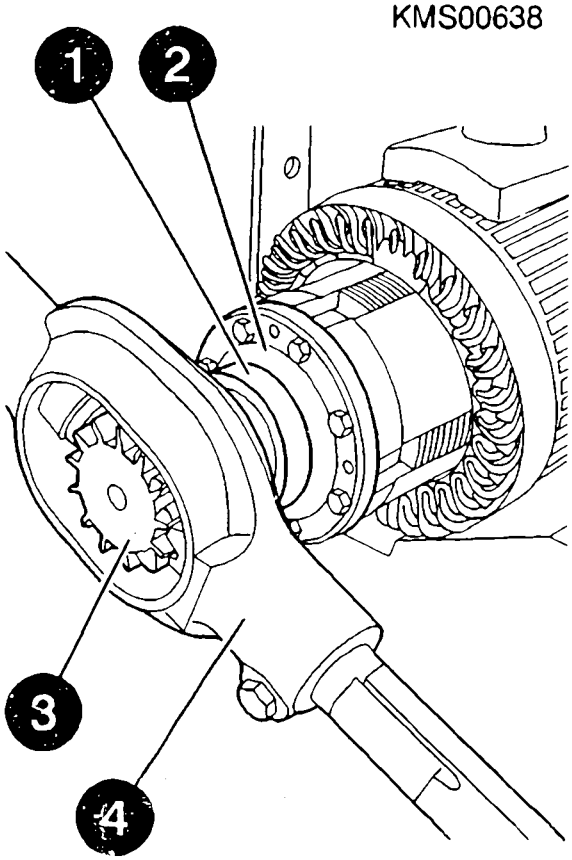
Checking overload protection

Insert support sleeve (1) over gear shaft into intermediate bearing (2). Insert pinion (3) in gear shaft. Use torquemeter (4) to check response moment in direction opposite to that of armature rotation.

Support sleeve:	to be improvised
Torquemeter:	0 986 617 166
Response moment of overload protection	
- Starter 0 001 60. ..:	350...420 Nm
- Starter 0 001 61. ..:	420...500 Nm

Continue: V22/1 Fig.: V21/2

KMS00638



CHECKING/REPAIRING MULTI-PLATE CLUTCH

Adjusting overload protection

Response moment is adjusted by removing (reduces response moment) or adding (increases response moment) shims.

Never use shims with a thickness of less than 0.35 mm.
If the total thickness of the shims exceeds 1.2 mm, a new clutch plate (steel) must be fitted in place of the shims.
Check response moment again.

Continue: V23/1

CHECKING/REPAIRING MULTI-PLATE CLUTCH

Checking overrunning torque

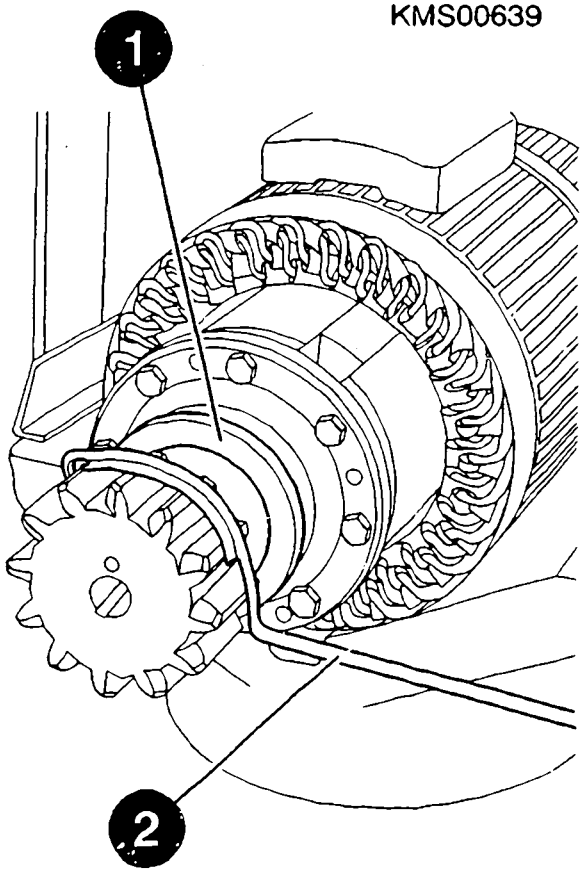
NOTE: Overrunning torque is checked with support sleeve (1) fitted.

Engage torquemeter (2) at pinion and move to horizontal position.

Torquemeter: 0 986 617 206

Continue: V24/1 Fig.: V23/2

KMS00639



CHECKING/REPAIRING MULTI-PLATE CLUTCH

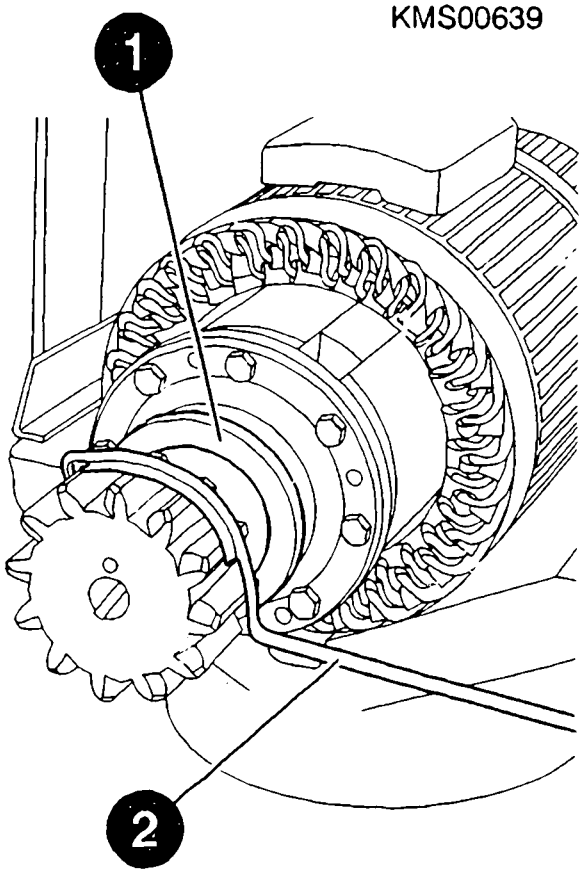
Checking overrunning torque

Check overrunning torque of multi-plate clutch in direction of armature rotation.

To do so, move weight until pinion starts to turn. Scale reading must be between 6...8.
This corresponds to an overrunning torque of 0,6...0,8 Nm.

Continue: V25/1 Fig.: V24/2

KMS00639



CHECKING/REPAIRING MULTI-PLATE CLUTCH

Checking overrunning torque

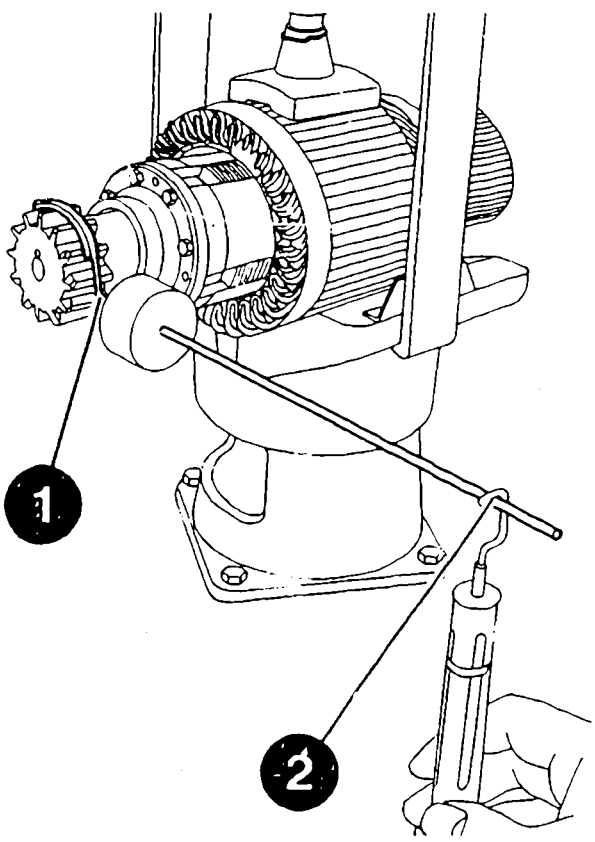
Proceed as follows if the torque applied with the torquemeter is insufficient:

Move weight to second mark "2.0" (1). Engage spring balance at last mark "8" (2).

Spring balance: 0 986 619 181

Continue: V26/1 Fig.: V25/2

KMS00640



CHECKING/REPAIRING MULTI-PLATE CLUTCH

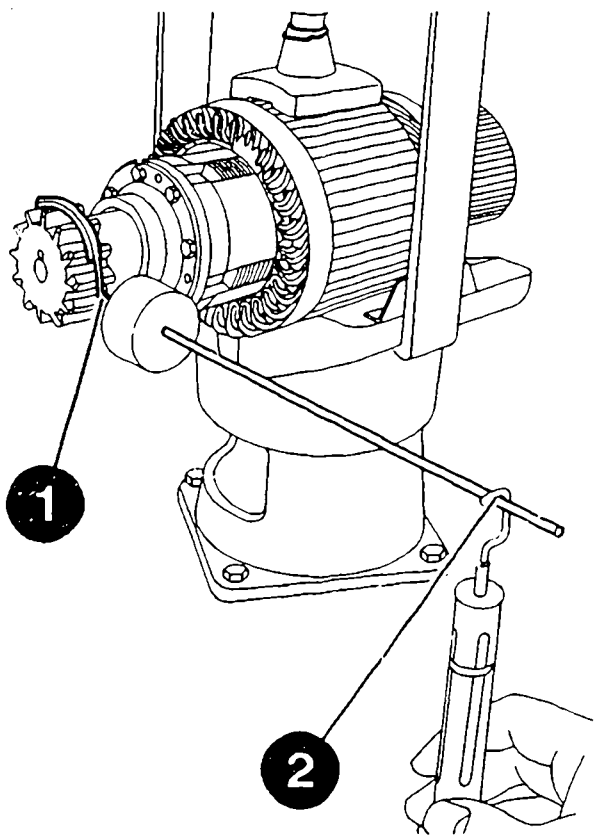
Checking overrunning torque

Pull on spring balance until pinion with armature starts to turn.
Take scale reading on spring balance.
Reading may be max. 0,30 kg.
Overrunning torque is then within the required range.
If this is not the case, check components and component assembly.
Detach pinion and support sleeve.

Overrunning torque: 0,6...1,0 Nm

Continue: V27/1 Fig.: V26/2

KMS00640



CHECKING/REPAIRING MULTI-PLATE CLUTCH

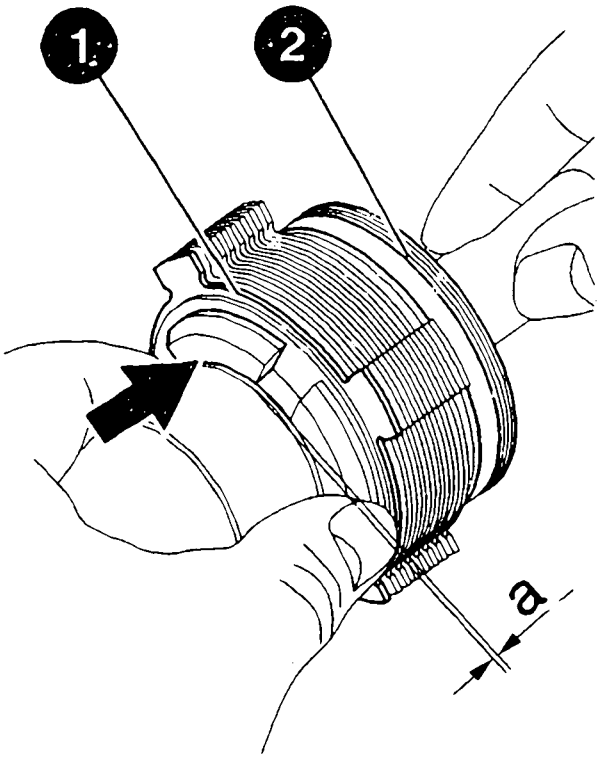
Checking axial play of gear shaft

Unscrew intermediate bearing from clutch housing and pull out multi-plate clutch.
Press multi-plate clutch (1) together slightly by hand in direction of arrow.
Take care not to squash spring lock washer (2).
Check dimension "a" between shoulder of gear shaft and clutch half (see Fig.).

Dimension "a": 0,5...1,3 mm

Continue: V28/1 Fig.: V27/2

KMS00642



CHECKING/REPAIRING MULTI-PLATE CLUTCH

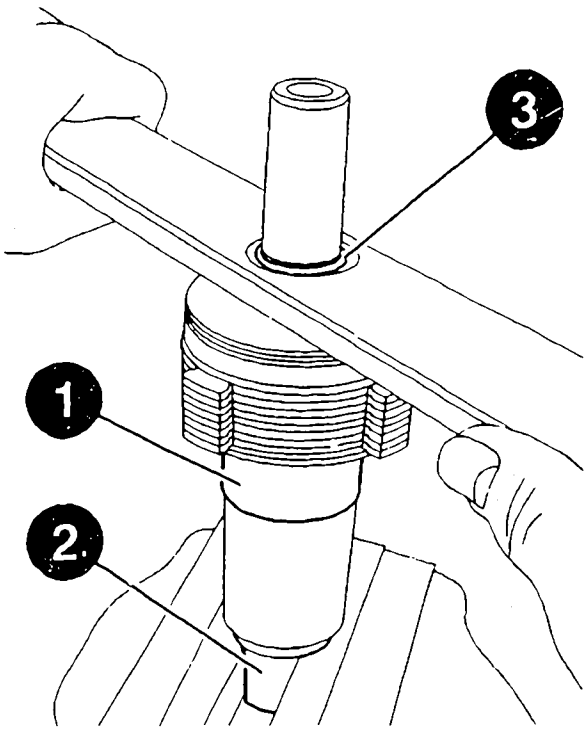
Tightening threaded ring

Slip multi-plate clutch (1) onto clamping pin (2) and tighten threaded ring (3).
Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque, threaded ring:	80...100 Nm

Continue: VI01/1 Fig.: V28/2

KMS00641



CHECKING/REPAIRING MULTI-PLATE CLUTCH

Caulking threaded ring

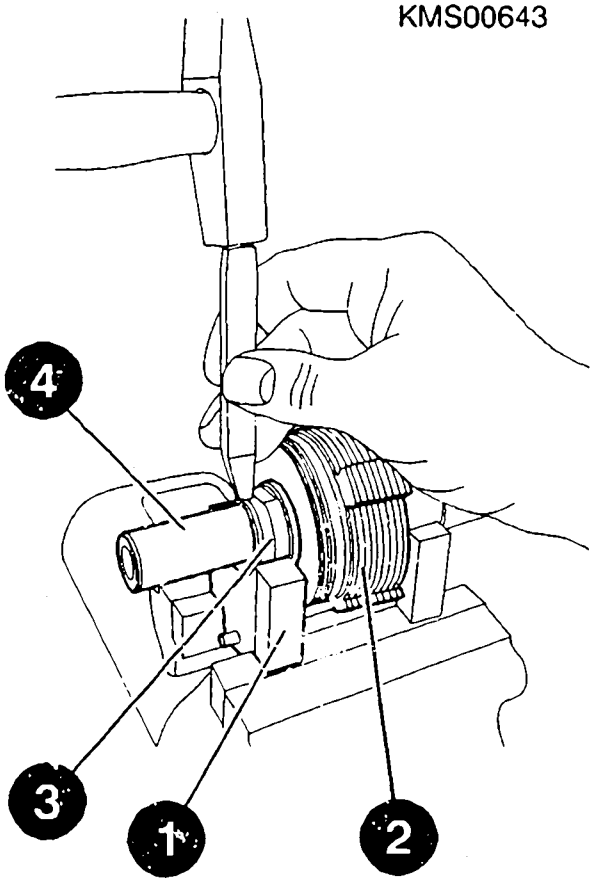
Clamp support (1) in vice.
Fit multi-plate clutch (2) and use tool to carefully caulk threaded ring (3) at collar in the area of the two gear shaft (4) notches.

ATTENTION: Only caulk threaded ring at non-hardened collar. Collar of threaded ring must not tear.

Support:	to be improvised
Caulking tool:	to be improvised

Continue: IV16/2 Fig.: VI01/2

KMS00643



CHECKING/REPAIRING ENGAGEMENT ROD

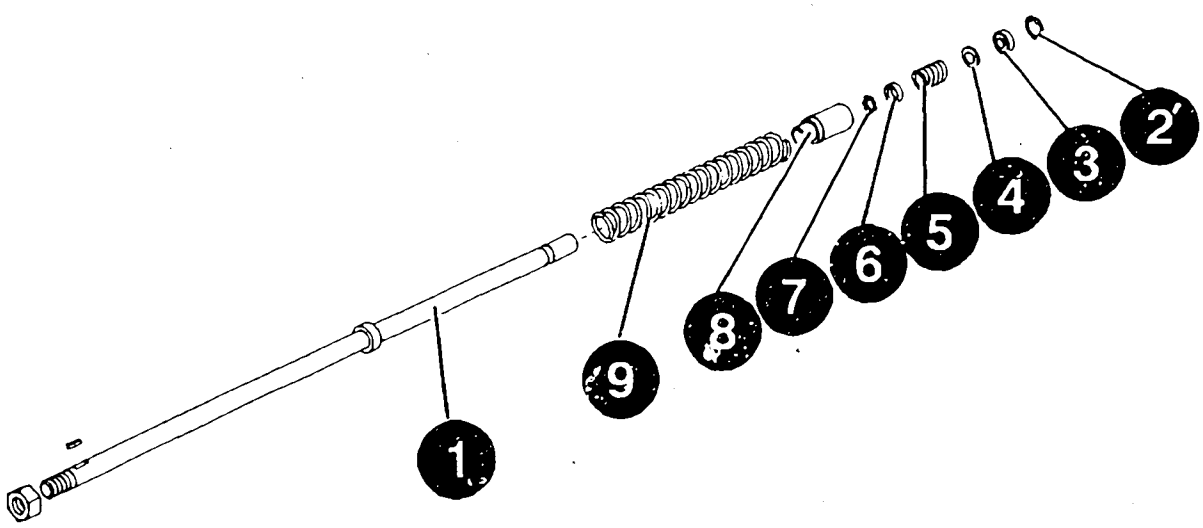
Disassembling engagement rod:

Pull compression spring (9) in direction of thread off engagement rod (1).
Clamp engagement rod vertically in vice between soft jaws.
ATTENTION: Take care not to damage thread.

Detach circlip (2) and move outer race (8).

Continue: VI03/1 Fig.: VI02/2

KMS00576



CHECKING/REPAIRING ENGAGEMENT ROD

Disassembling engagement rod (continued):

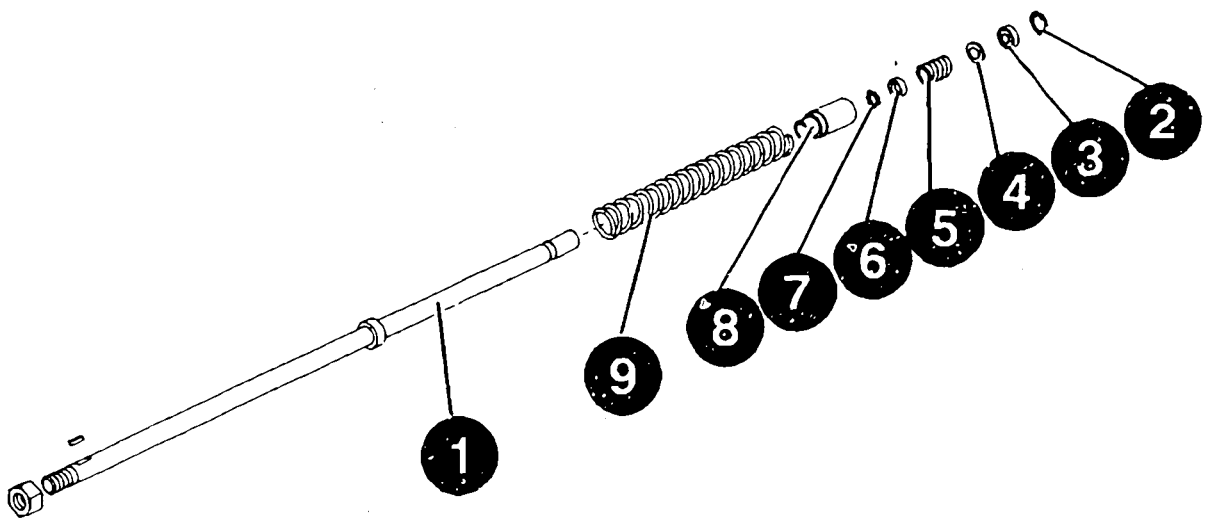
Detach deep-groove ball bearing (3), cover plate (4), compression spring (5) and retaining ring (6). Take out 7 balls (7).

NOTE: Pay attention to sequence of components.

Clean components and visually inspect for cracks.
Replace damaged components.

Continue: VI04/1 Fig.: VI03/2

KMS00576



CHECKING/REPAIRING ENGAGEMENT ROD

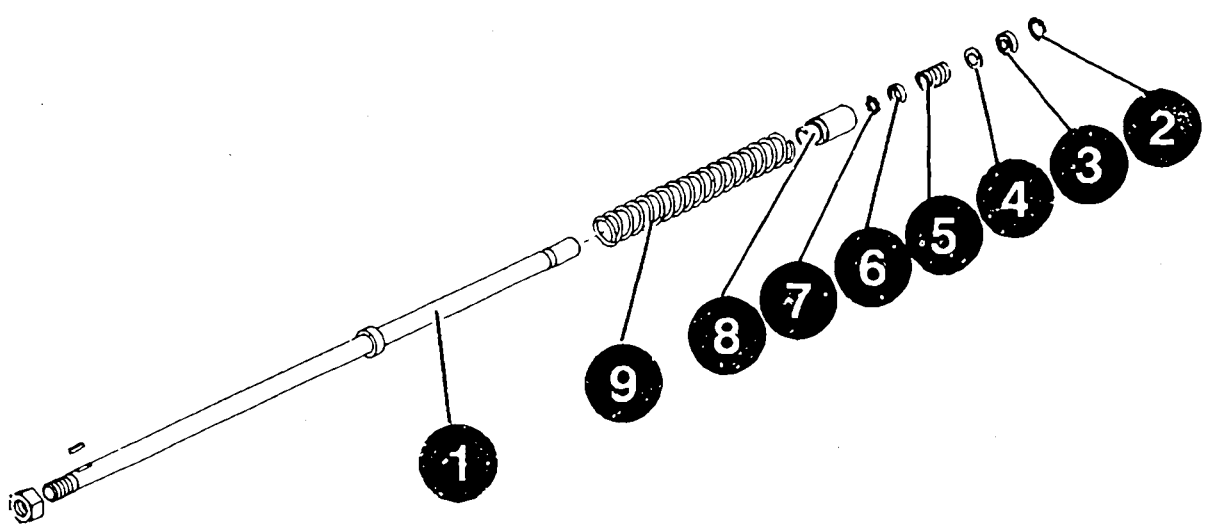
Assembling engagement rod:

Apply small quantity of grease to all components. Slip outer race (8) onto engagement rod (1). Insert 7 balls (7) in groove of engagement rod (1). The grease holds the balls in position. Pull up outer race (8); insert retaining ring (6), compression spring (5), cover plate (4) and deep-groove ball bearing (3) in outer race (8). Insert circlip (2) and slip compression spring (9) over engagement rod.

Grease VS 10832-Ft: 5 932 240 150

Continue: IV16/2 Fig.: VI04/2

KMS00576



CHECKING/REPAIRING ARMATURE

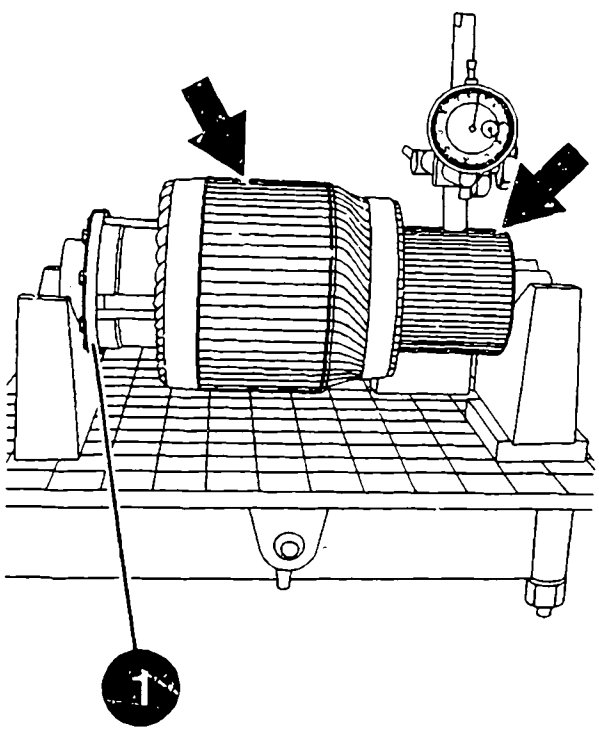
Checking concentricity of commutator and armature laminated core (arrows)

To do so, fit intermediate bearing (1) with old bolts. If radial run-out of commutator is outside stated range, it must be turned down.

Magnetic measurement stand:	4 851 601 124
Dial gauge:	1 687 233 011
Radial run-out	
- Commutator:	< 0,03 mm
- Armature laminated core:	< 0,1 mm

Continue: VI06/1 Fig.: VI05/2

KMS00649



CHECKING/REPAIRING ARMATURE

Turning down commutator

To turn down, clamp armature at fitted intermediate bearing with three-jaw chuck on INSIDE - not on outside at ball bearing seat.

Clamp armature at commutator end with live center in tailstock.

Turn down commutator.
Pay attention to minimum diameter.

Minimum diameter: 77 mm

Continue: VI06/2

CHECKING/REPAIRING ARMATURE

Turning down commutator

ATTENTION: On starters manufactured before FD 461, the segment insulation of the commutator contains asbestos. Use is to be made of a suitable extraction system when working.
On starters as of FD 461 there is no asbestos in the segment insulation.

After turning down, the segment insulation of the commutator must be sawn out using a suitable tool.

Continue: VI07/1

CHECKING/REPAIRING ARMATURE

Turning down commutator

If use is made of a commutator saw, a suitable extraction system and a thrust piece for supporting the armature must be employed.

Turn commutator down again after sawing and check concentricity. Pay attention to minimum diameter. Then check armature for interturn short circuit, short to ground and continuity.

Thrust piece: to be improvised

Continue: VI08/1

CHECKING/REPAIRING ARMATURE

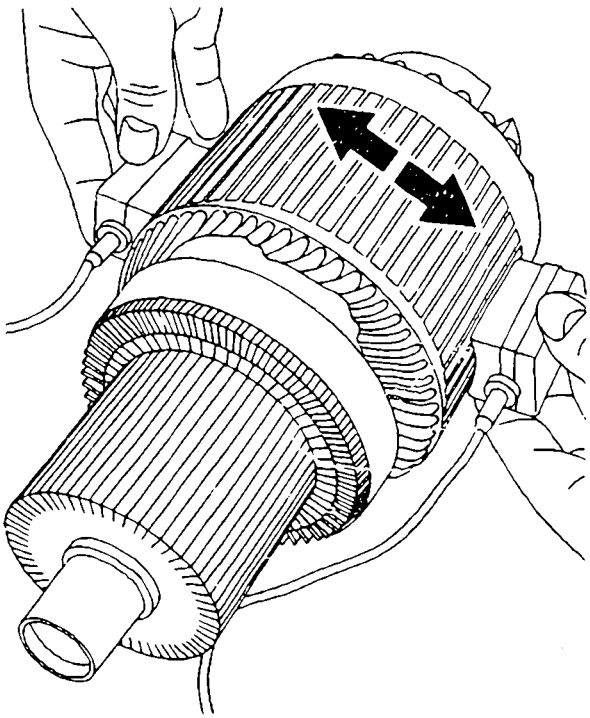
- Checking armature for interturn short circuit

Use tester and test probes to check for interturn short circuit.

Interturn short-circuit tester with test probes: 0 986 619 110

Continue: VI09/1 Fig.: VI08/2

KMS00631



CHECKING/REPAIRING ARMATURE

Checking armature for short to ground

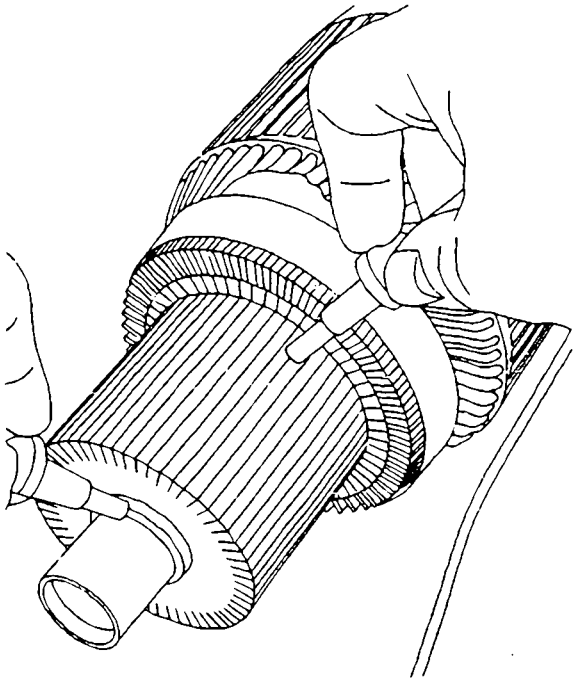
Use tester and test prods to perform check
(black laminations are an indication of open circuit)

Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101
Test voltage	
Ground short test:	80 V*

* = AC

Continue: VI10/1 Fig.: VI09/2

KMS00632



CHECKING/REPAIRING ARMATURE

Replacing bushing in armature

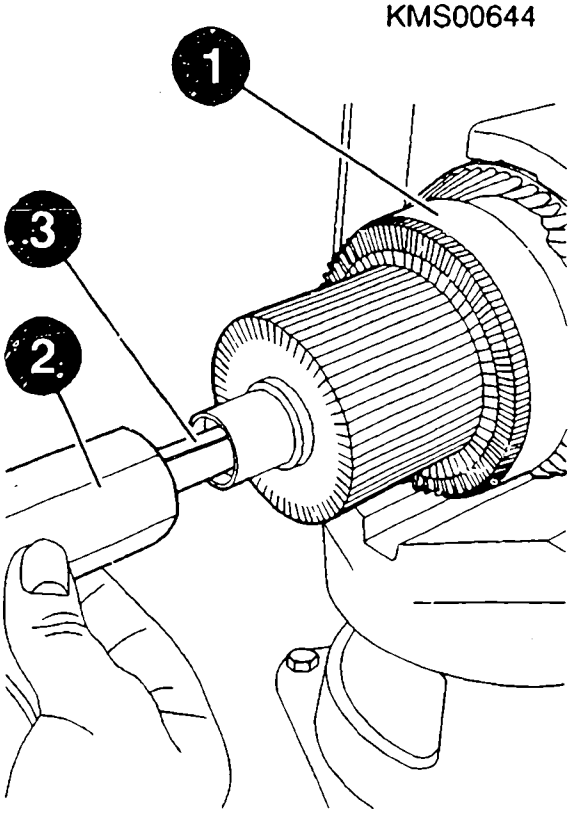
Only replace bushing if outer race of engagement rod reveals signs of wear, seizure, scoring or temperature-induced color changes.

Removing:
Clamp armature (1) in clamping support. Use puller (2) and spring collet (3) to pull out bushing.

Clamping support:	0 986 619 362
Puller:	0 986 617 233
Spring collet 18.1 mm:	0 986 617 240

Continue: VI11/1 Fig.: VI10/2

KMS00644



CHECKING/REPAIRING ARMATURE

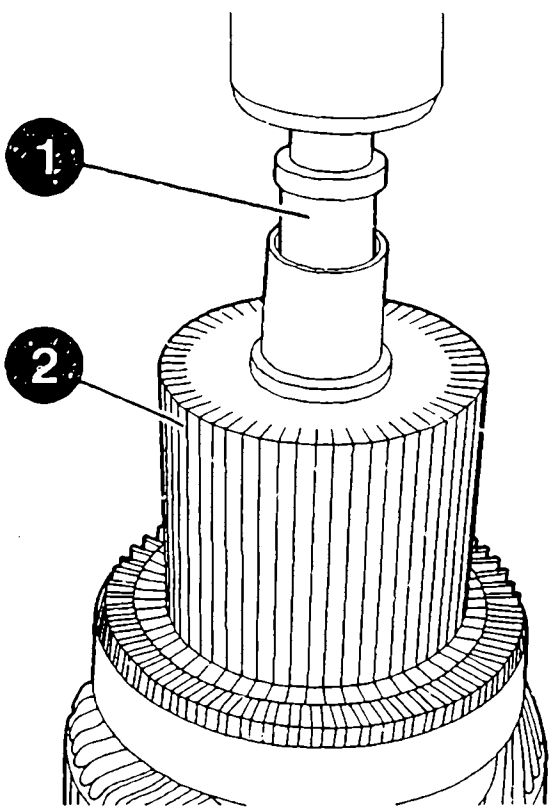
Replacing bushing in armature
Installing:

Soak new bushing for 8 hours in suitable oil before installing.
Press home bushing in armature (2) with pressing-in mandrel (1) on mandrel press.
Treat bushing with smoothing mandrel.

Mandrel press:	comm. avail.
Pressing-in mandrel:	to be improvised
Smoothing mandrel:	to be improvised
Oil VS 13834-01:	5 962 260 6..

Continue: VI12/1 Fig.: VI11/2

KMS00645



CHECKING/REPAIRING ARMATURE

Replacing needle bearing in armature

Only replace needle bearing if:

- Needle bearing is damaged
- Traces of rust can be seen on needle bearing
- Surface of needle bearing on gear shaft shows signs of wear, seizure, scoring or temperature-induced color changes

Continue: VI13/1

CHECKING/REPAIRING ARMATURE

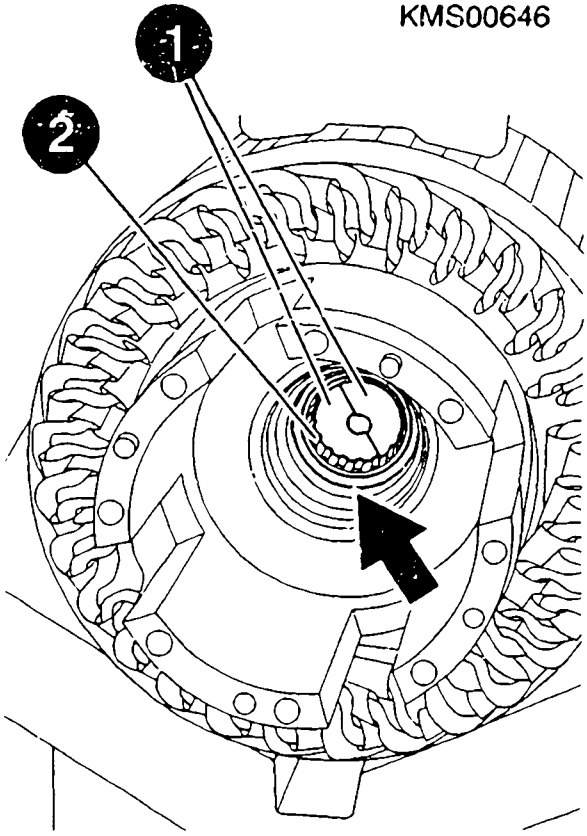
Replacing needle bearing in armature
Removing:

Clamp armature in clamping support.
ATTENTION: DANGER OF INJURY
Use suitable tool to press out snap ring (arrow) - already dismantled in Fig.
Position the two halves (1) of the pressing-out tool behind needle bearing (2).

Clamping support: 0 986 619 362
Pressing-out tool: to be improvised

Continue: VI14/1 Fig.: VI13/2

KMS00646



CHECKING/REPAIRING ARMATURE

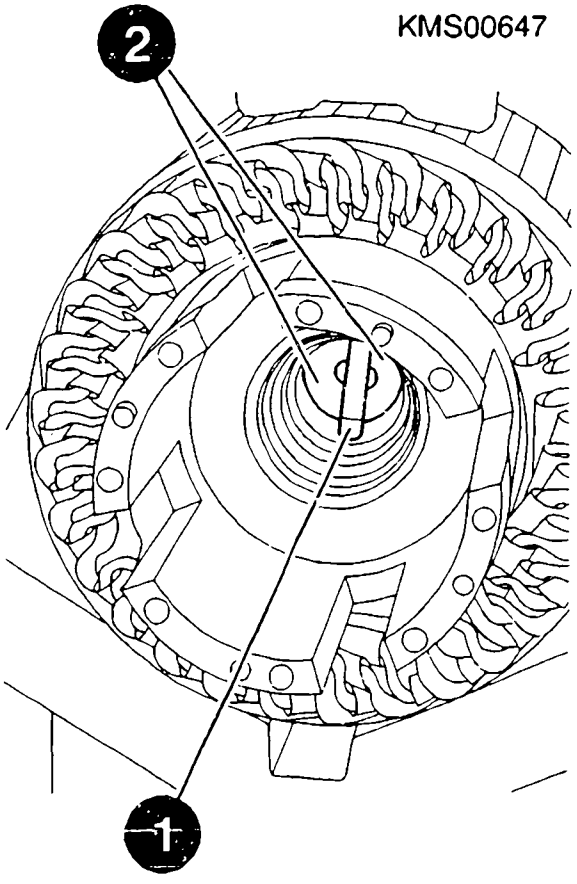
Replacing needle bearing in armature
Removing (continued):

Insert expanding mandrel of pressing-out tool (1) from commutator end between the two halves (2).

Press out needle bearing on mandrel press.

Mandrel press: comm. avail.

Continue: VI15/1 Fig.: VI14/2



CHECKING/REPAIRING ARMATURE

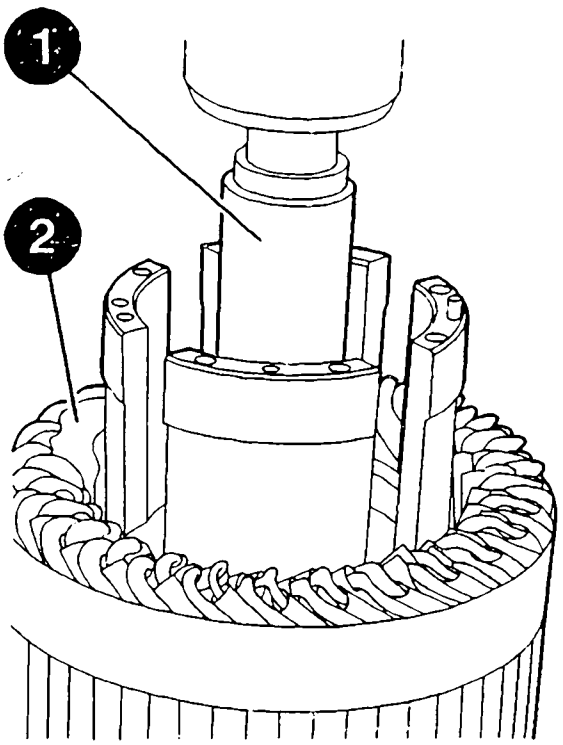
Replacing needle bearing in armature
Installing:

Grease new needle bearing before installing.
Slip needle bearing onto pressing-in mandrel (1) such that non-labelled side is facing pressing-in mandrel and press home in armature (2).
ATTENTION: DANGER OF INJURY
Insert new snap ring in groove.

Mandrel press:	comm. avail.
Pressing-in mandrel:	to be improvised
Grease VS 10832-Ft:	5 932 240 150

Continue: IV16/2 Fig.: VI15/2

KMS00648



CHECKING WINDINGS

Checking excitation winding for short to ground and continuity

Use tester and test prods to perform check. Tension cable lugs during measurement or press onto insulating surface.

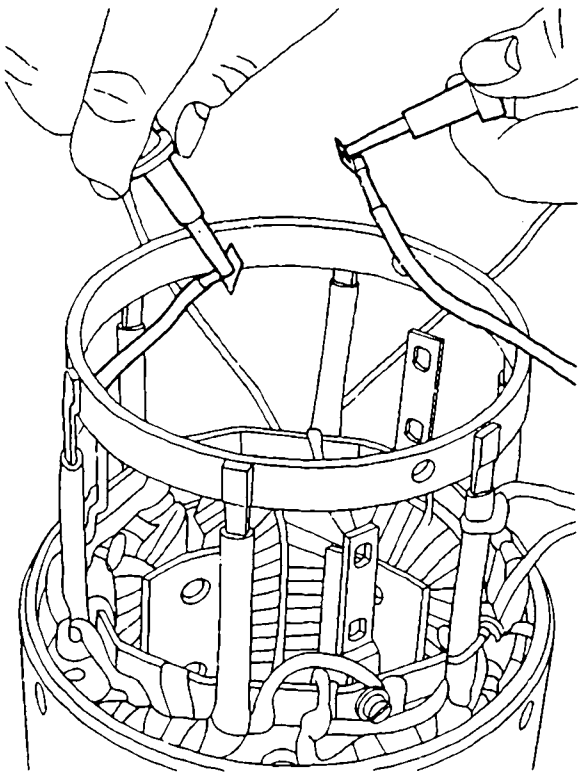
Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 114

Test voltage	
Ground short test:	80 V*
Continuity test:	40 V*

* = AC

Continue: VI17/1 Fig.: VI16/2

KMS00650



CHECKING WINDINGS

Checking resistance of brake winding

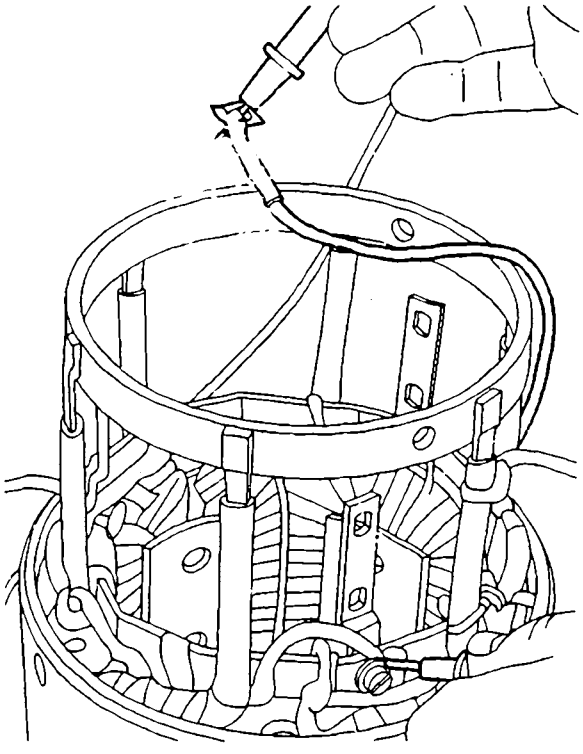
Use alternator tester to perform check.

Refer to following table for resistances of the various types of starter.

Alternator tester: 0 684 201 200

Continue: VI18/1 Fig.: VI17/2

KMS00651



CHECKING WINDINGS

BRAKE WINDING RESISTANCES

Starter type	Resistance
* 24 V/10 kW:	0,05...0,06 Ohm
* 24 V/15 kW:	0,06...0,08 Ohm
* 24 V/18 kW:	0,05...0,06 Ohm
* 32 V/36 V :	0,08...0,09 Ohm

Continue: VI18/2

CHECKING WINDINGS

Checking resistance of shunt winding

Use alternator tester to perform check.

Resistances

- Type 24 V/18 kW:	0,75...0,83 Ohm
- Type 32 V/36 V:	26,1...28,8 Ohm

Alternator tester: 0 684 201 200

Continue: IV16/2

REPLACING EXCITATION WINDING

Replace damaged, scorched or unsoldered windings.

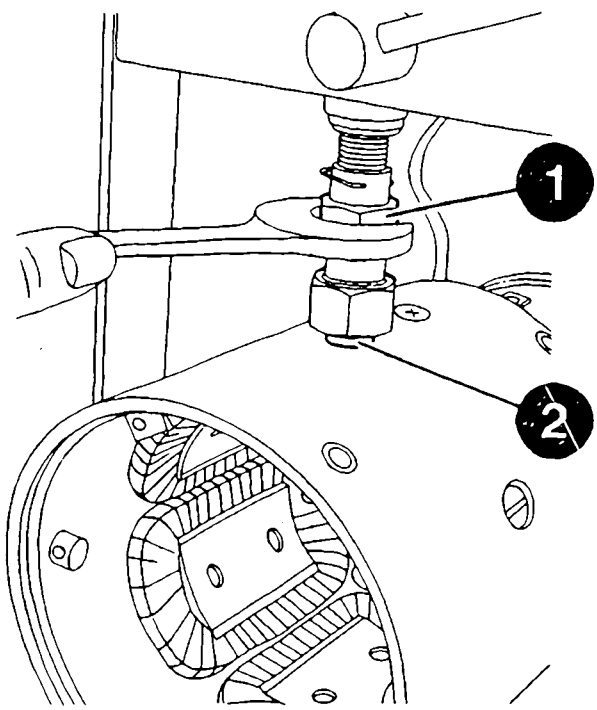
Removing excitation winding:

Insert stator housing in clamping support.
Mark position of pole shoes.
Unfasten pole shoe bolts with pole shoe screwdriver (1) and bit (2).
Take out pole shoes and windings.

Pole shoe screwdriver: 0 986 619 393
Bit: depending on pole shoe bolts

Continue: VI20/1 Fig.: VI19/2

KMS00652



REPLACING EXCITATION WINDING

Installing excitation winding:

Insert excitation windings with pole shoes in stator housing and tighten pole shoe bolts slightly.

Pay attention to marks.

Press in fitting mandrel on mandrel press.

Mandrel press:	comm. avail.
Fitting mandrel:	to be improvised

Continue: VI20/2

REPLACING EXCITATION WINDING

Installing excitation winding (continued):

Position stator housing in clamping support. Tighten pole shoe bolts.

Use torque wrench.

Press out fitting mandrel on mandrel press.

Pole shoe screwdriver:	0 986 619 393
Bit:	comm. avail.

Tightening torque, pole shoe bolts:	41...51 Nm

Continue: IV16/2

STARTER ASSEMBLY TABLE

Continue: VI21/2

STARTER ASSEMBLY TABLE

Continue: VI22/1

STARTER ASSEMBLY TABLE

Continue: I01/1

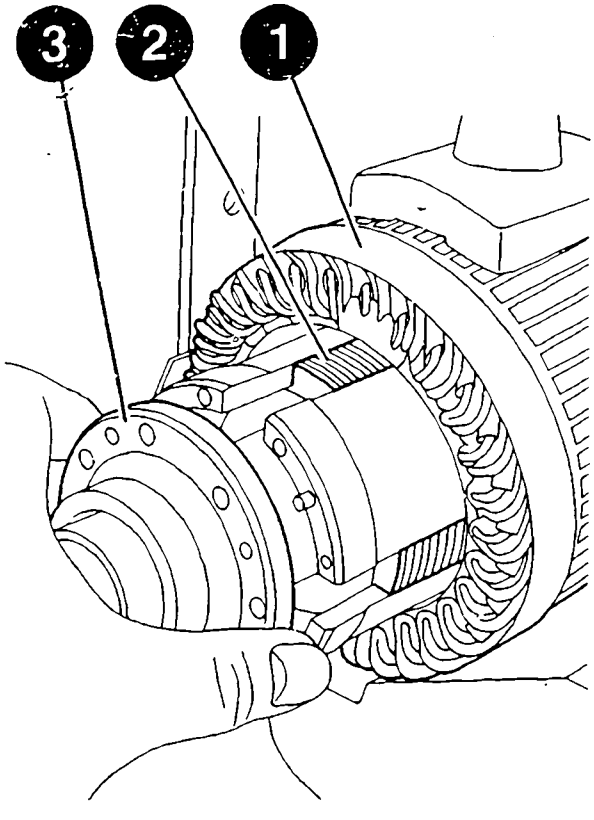
ASSEMBLING MULTI-PLATE CLUTCH

Lubricate as per schedule before and during assembly.
Clamp armature (1) in clamping support.
Insert multi-plate clutch (2) in clutch housing.
Screw intermediate bearing (3) to clutch housing. Pay attention to asymmetrical position of spring pins.
Always make use of new micro-encapsulated bolts.
Use torque wrench.

Clamping support:	0 986 619 362
Torque wrench:	comm. avail.
Tightening torque:	7...8 Nm

Continue: VI21/1 Fig.: VI23/2

KMS00637



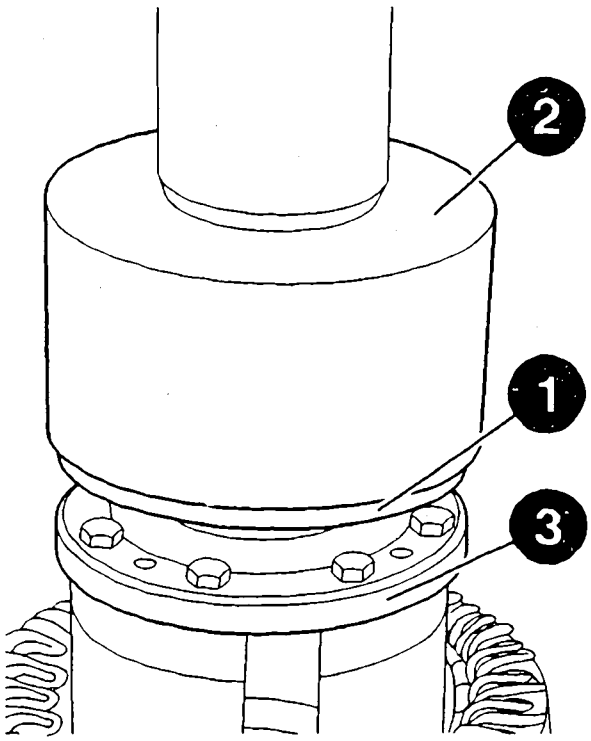
ASSEMBLING DEEP-GROOVE BALL BEARING ON INTERMEDIATE BEARING

Use pressing-on sleeve (2) at inner race to press deep-groove ball bearing (1) onto intermediate bearing (3) with mandrel press.

Mandrel press: comm. avail.
Pressing-on sleeve: to be improvised

Continue: VI21/1 Fig.: VI24/2

KMS00653



ASSEMBLING COMMUTATOR END SHIELD

NOTE: In the case of TF-starter 0 001 613 ... apply Hylomar sealant to fitting surface between commutator end shield and stator housing before assembling commutator end shield.

Hylomar sealant
VS 9844 Kk: 5 927 350 002

Continue: VI26/1

ASSEMBLING COMMUTATOR END SHIELD

Clamp stator housing in clamping support.

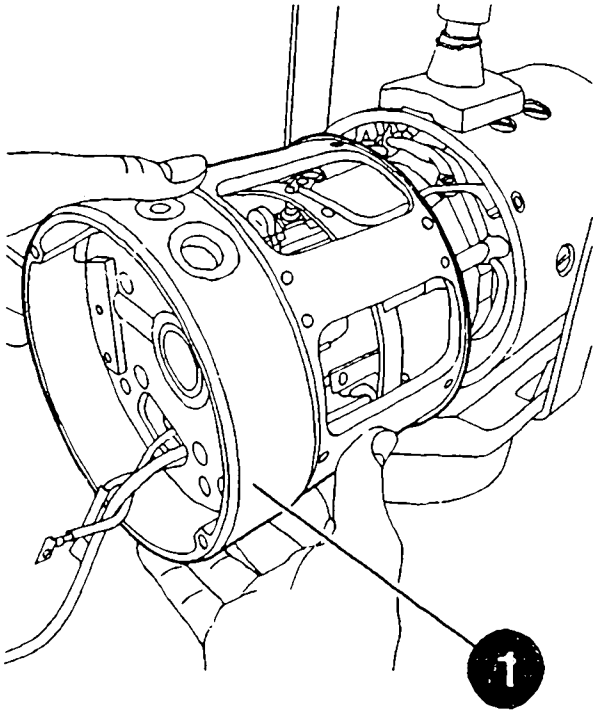
Attach commutator end shield (1) to stator housing.
Pay attention to straight pin (locator) in stator housing.
Ensure proper cable penetration.

NOTE: Take care not to damage insulation of protruding connections.

Clamping support: 0 986 619 362

Continue: VI27/1 Fig.: VI26/2

KMS00615



ASSEMBLING COMMUTATOR END SHIELD

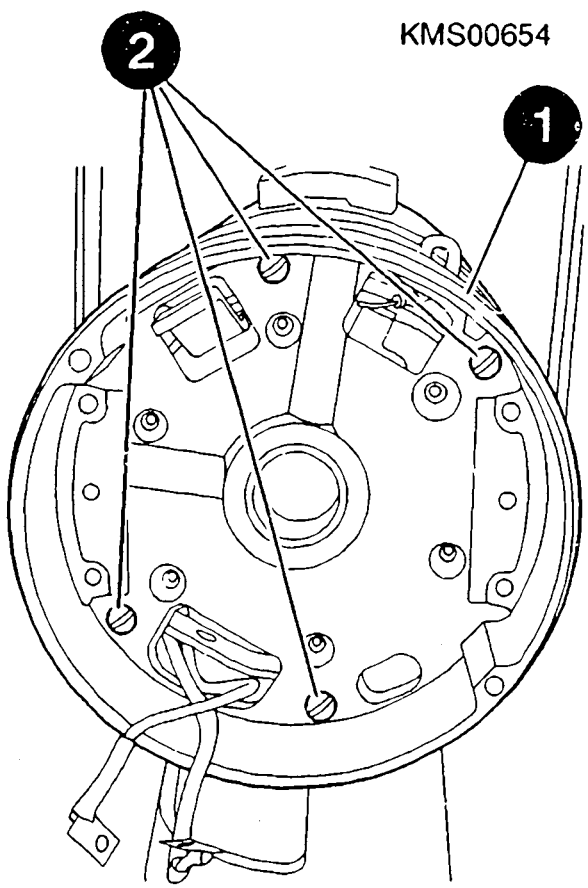
Insert insulating sleeves of commutator bolts into commutator end shield.

Secure commutator end shield (1). Use torque wrench.

Then caulk bolts (2).

Torque wrench:	comm. avail.
Tightening torque:	5,5...6,8 Nm

Continue: VI21/1 Fig.: VI27/2



ASSEMBLING ARMATURE

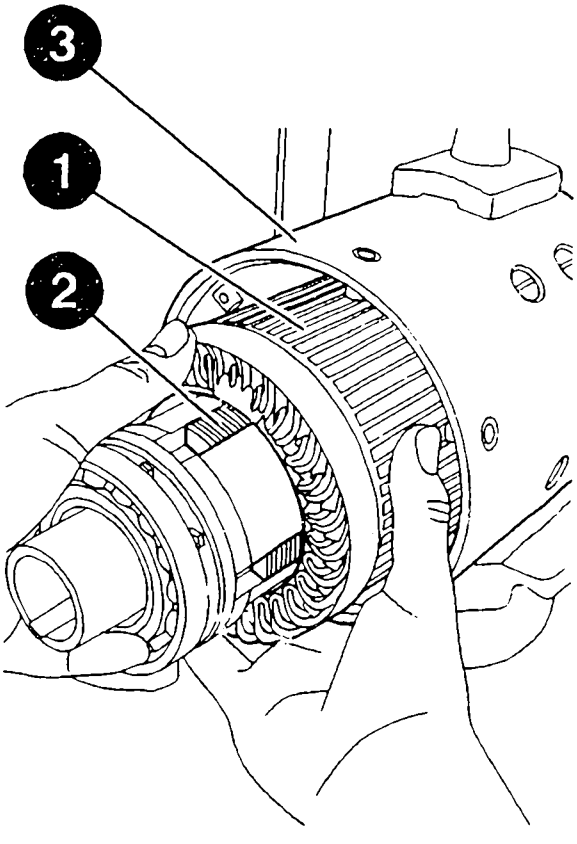
Slip shim (steel shim), stop disc and shim for adjusting armature axial play onto commutator end of armature shaft. Insert armature (1) complete with multi-plate clutch (2) from drive end shield side into stator housing (3). Pay attention to shims/discs on armature shaft.

NOTE: Take care not to damage excitation winding.

Clamping support: 0 986 619 362

Continue: VI21/1 Fig.: VI28/2

KMS00655



ASSEMBLING DRIVE END SHIELD

NOTE: In the case of TF-starter 0 001 613 ... apply Hylomar sealant to fitting surface between drive end shield and stator housing before assembling drive end shield.

Hylomar sealant
VS 9844 Kk: 5 927 350 002

Continue: VII02/1

ASSEMBLING DRIVE END SHIELD

Apply small quantity of grease to sealing lip of radial shaft oil seal (1) in drive end shield.

Slip drive end shield (2) onto intermediate bearing.

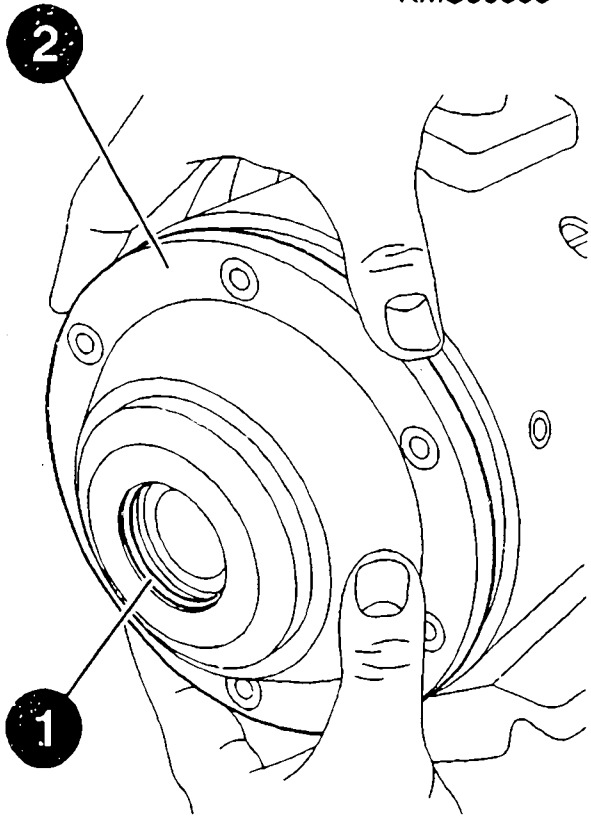
ATTENTION: Take care not to damage radial shaft oil seal.

Secure drive end shield (2) with 2 bolts.
Then check armature axial play.

Grease VS 10832-Ft: 5 932 240 150

Continue: VI21/1 Fig.: VII02/2

KMS00656



CHECKING ARMATURE AXIAL PLAY

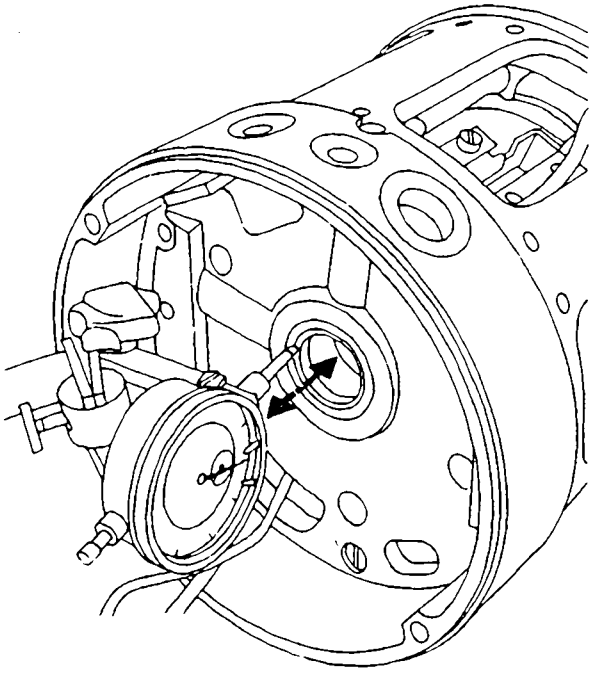
Measure armature axial play at commutator end using depth gauge or dial gauge.

To do so, move armature as far as it will go in both directions (arrows) and measure play.
Adjust armature axial play on commutator-end armature shaft only by means of outer shim. Check freedom of movement of armature.

Depth gauge:	comm. avail.
Magnetic measurement stand:	4 851 601 124
Dial gauge:	1 687 233 011
Armature axial play:	0,2...0,4 mm

Continue: VII04/1 Fig.: VII03/2

KMS00657



CHECKING ARMATURE AXIAL PLAY

Completely screw on drive end shield after setting armature axial play.

Use torque wrench.

Check freedom of movement of armature.

Torque wrench:	comm. avail.
Tightening torque:	9...11 Nm

Continue: VI21/1

ASSEMBLING ENGAGEMENT ROD

Grease engagement rod.

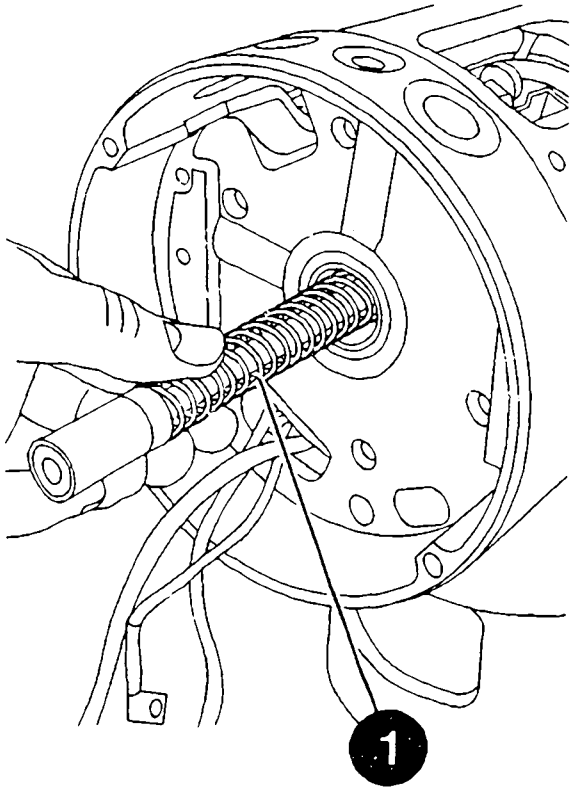
Insert engagement rod into armature from commutator end without feather key.

NOTE: New engagement rods and new pinions were introduced as of FD 821 (Jan. 1978).
New pinions suitable for both old and new engagement rods.
New engagement rods are only suitable for new pinions.

Grease VS 10832-Ft: 5 932 240 150

Continue: VI21/1 Fig.: VII05/2

KMS00613



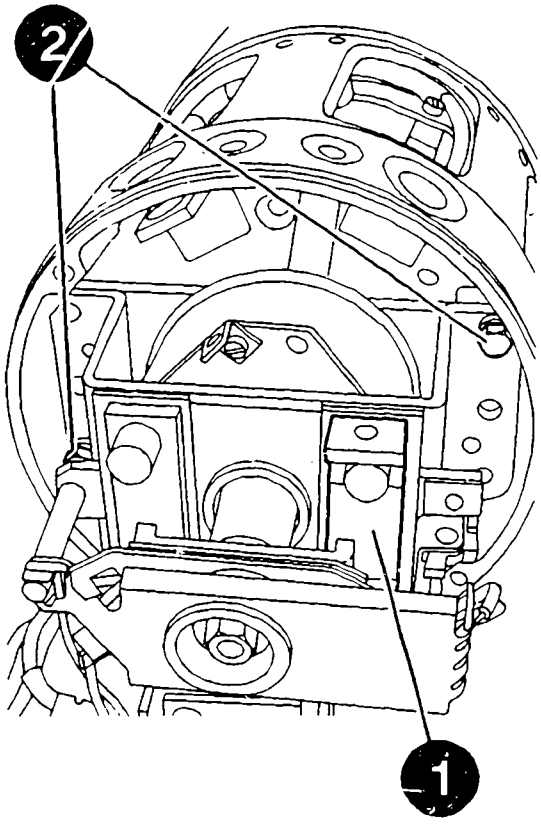
ASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Use 2 hexagon bolts (2) to pre-assemble starting-motor solenoid (1) together with control relay.

ATTENTION: DANGER OF INJURY
Engagement rod is subject to spring pretension and springs out of armature on removing starting-motor solenoid.

Continue: VII07/1 Fig.: VII06/2

KMSC0658



ASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

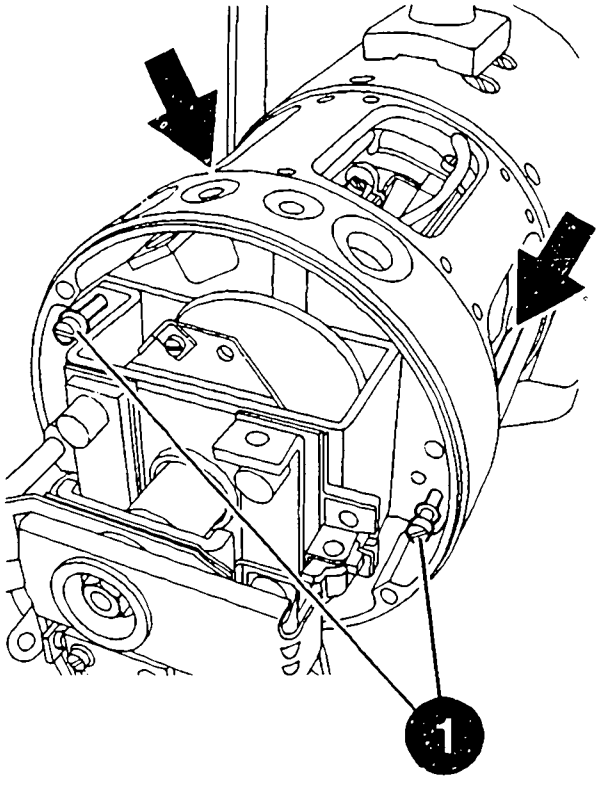
Route cheese-head bolts (1) through insulating tubing (arrows) and secure.

Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	5,5...6,8 Nm

Continue: VII08/1 Fig.: VII07/2

KMS00659



ASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Fit the two remaining hexagon bolts and tighten all 4 hexagon bolts.

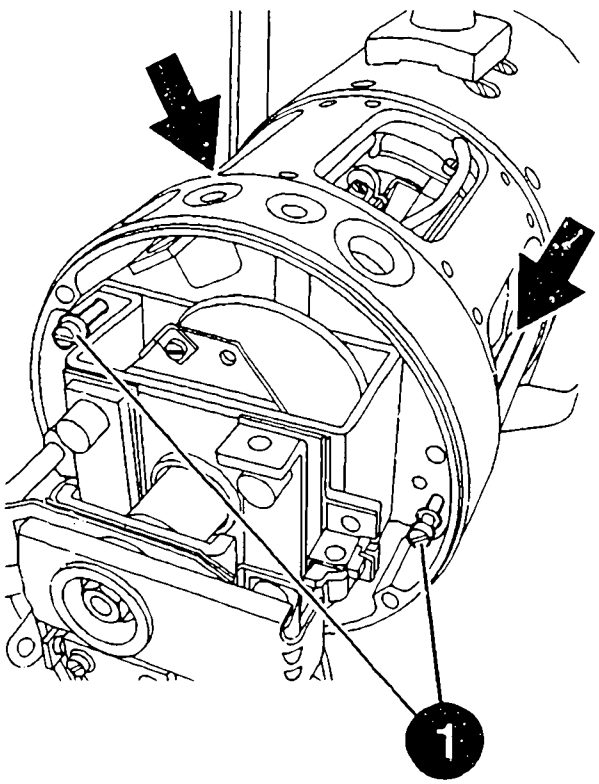
Versions with thermoswitch only:
In doing so, attach connection term. 50 with cable clamp.

Use torque wrench.
Pay attention to proper positioning of cable in cable clamp.

Torque wrench:	comm. avail.
Tightening torque:	8,4...10,5 Nm

Continue: VII09/1 Fig.: VII08/2

KMS00659

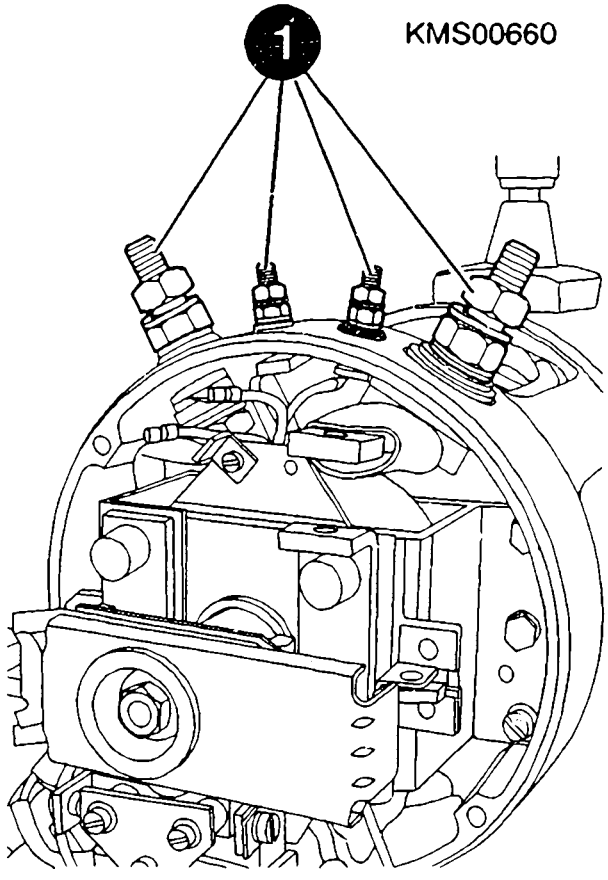


ASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Completely install all connections (1).

ATTENTION: Note sequence of individual washers and insulating parts.
Watch out for insulating sleeves in holes in commutator end shield.

Continue: VII10/1 Fig.: VII09/2

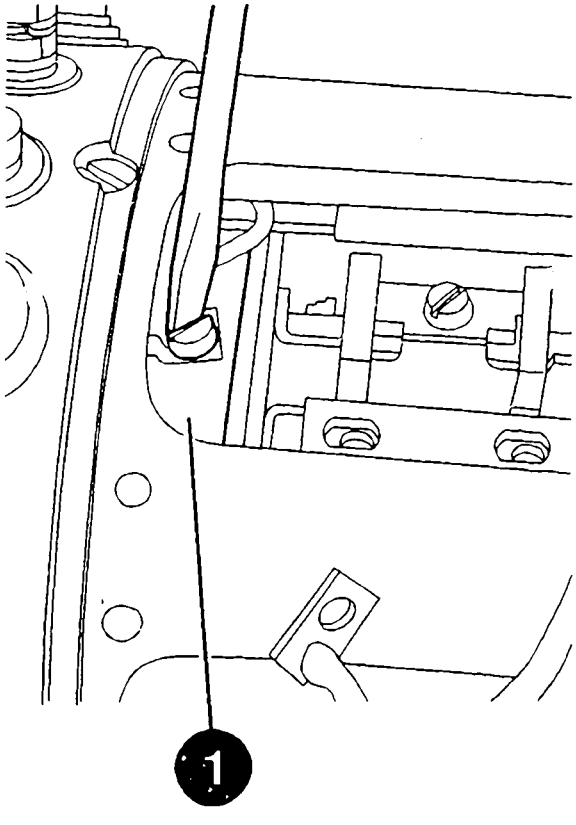


ASSEMBLING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Attach all connections and unions to excitation winding bar (1).

Continue: VI21/1 Fig.: VII10/2

KMS00603



CONNECTING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

Make all electrical connections at starting-motor solenoid and control relay in line with appropriate circuit diagram.

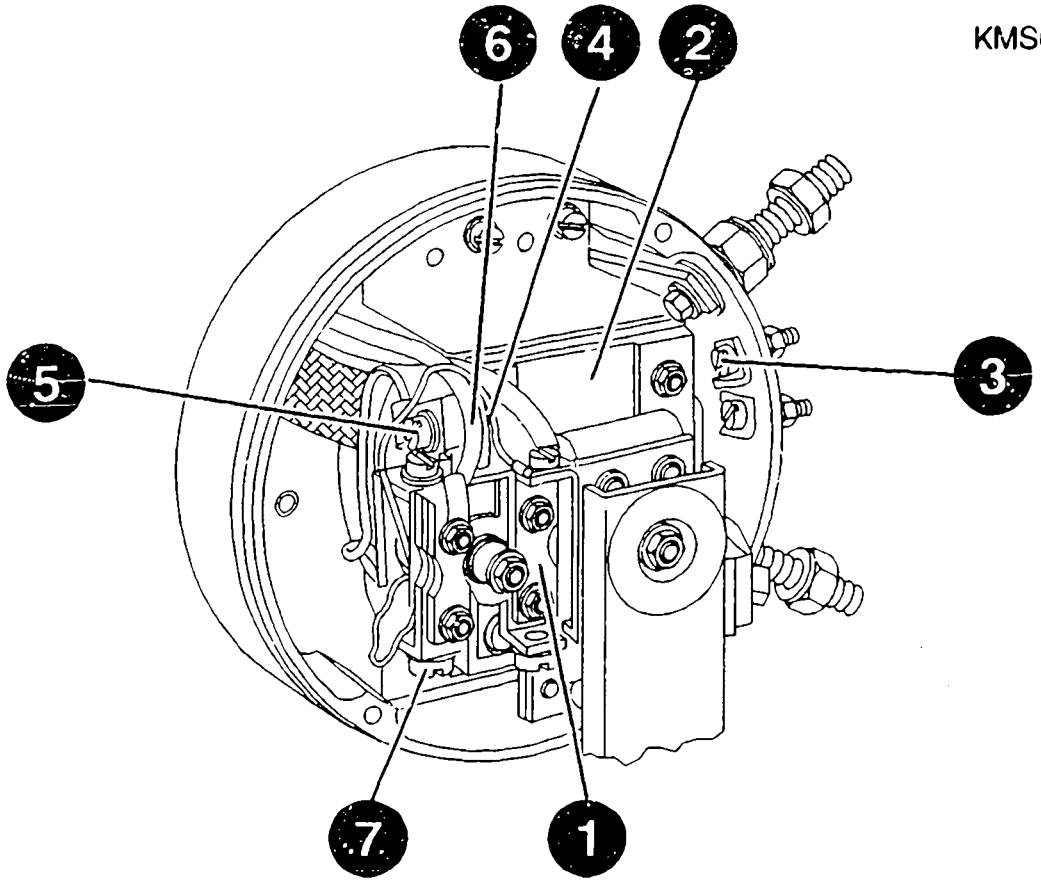
On tightening, use pliers to stop cable lugs turning and thus avoid contact with other parts of relay.

Continue: VII12/1

CONNECTING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

1 = Control relay
2 = Starting-motor solenoid
3 = Start of solenoid winding of control relay: YELLOW
Start of holding winding: BLUE
4 = End of solenoid winding of control relay: YELLOW
End of holding winding: BLUE
Negative connecting cable: RED

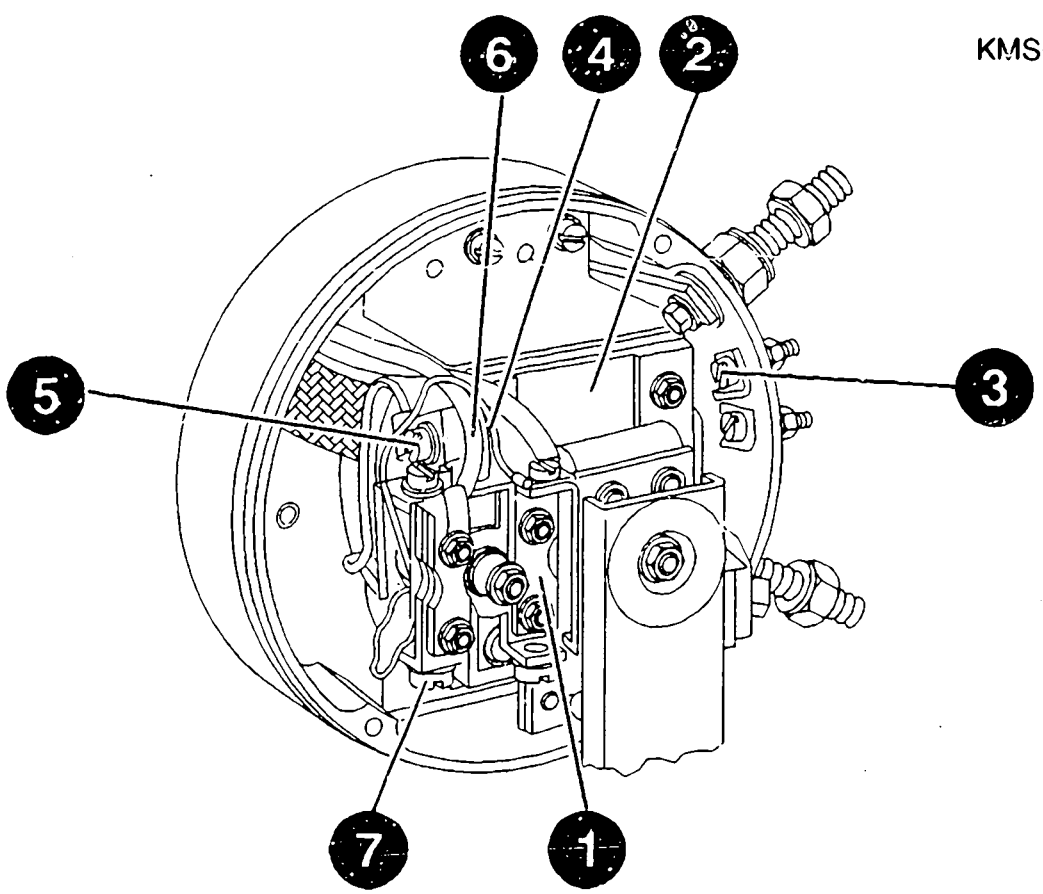
Continue: VII13/1 Fig.: VII12/2



CONNECTING STARTING-MOTOR SOLENOID WITH CONTROL RELAY

5 =	Start of opposing winding:	BLACK
	End of pull-in winding:	BLACK
6 =	Brake winding connection:	YELLOW
7 =	End of opposing winding:	WHITE
	Start of pull-in winding:	YELLOW

Continue: VI21/1 Fig.: VII13/2



ASSEMBLING PINION

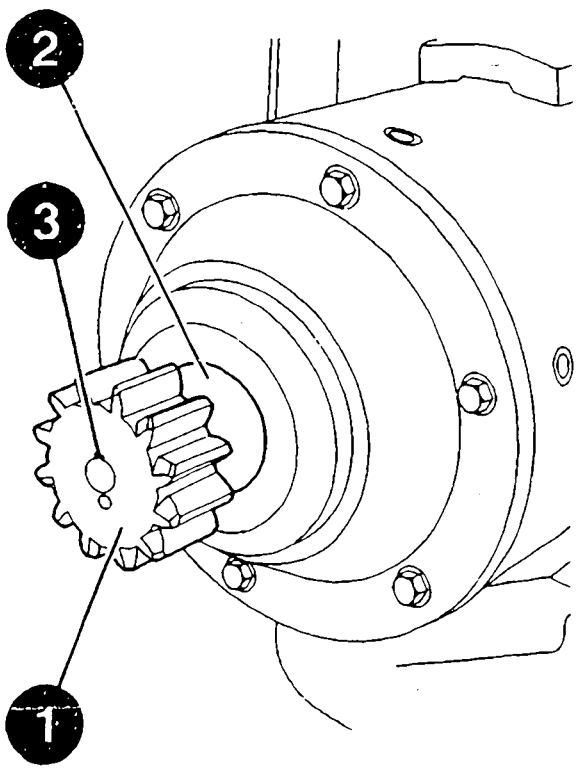
Insert pinion (1) in gear shaft (2) and turn such that slot (3) for feather key of engagement rod is facing upwards.

Pull off pinion; turn engagement rod such that slot for feather key is also facing upwards.

Insert feather key in engagement rod.

Continue: VII15/1 Fig.: VII14/2

KMS00661



ASSEMBLING PINION

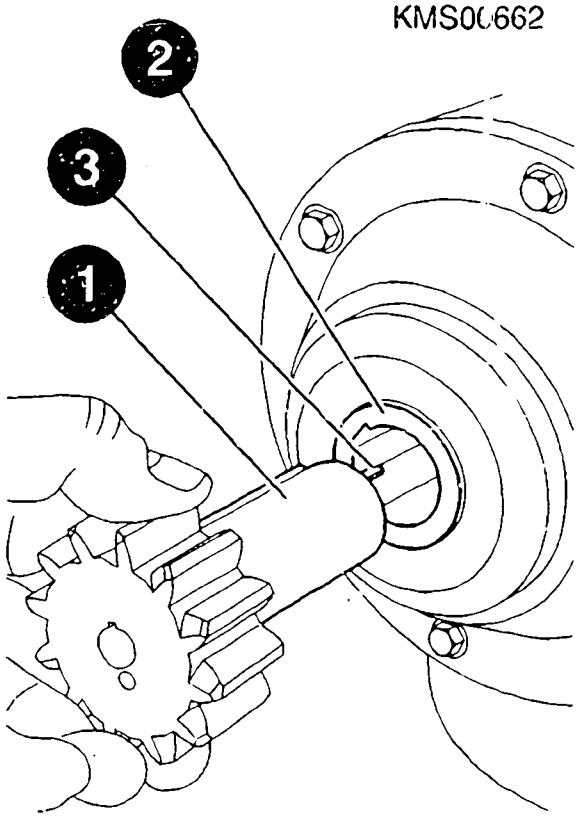
Insert pinion (1) in gear shaft (2). Watch out for feather key (3).

NOTE: In the case of the reduction gear of TF-starters, insert pinion together with reduction gear wheel in gear shaft.

ATTENTION: Make sure feather key of engagement rod engages in pinion slot.

Continue: VII16/1 Fig.: VII15/2

KMS00662



ASSEMBLING PINION

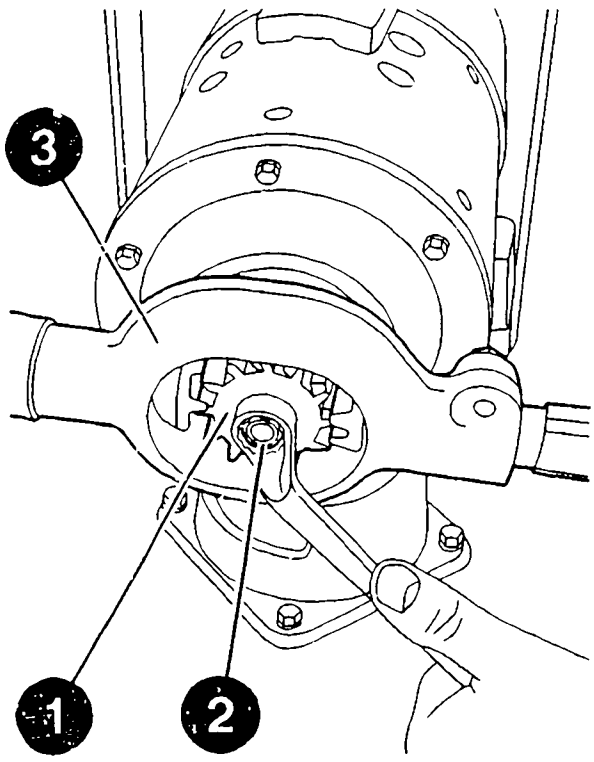
Secure pinion (1) with new Uni-Stop nut (2).
Use torque wrench.

Employ torquemeter (3) as support.
NOTE: In the case of TF-starters, insert pinion for this purpose in reduction gear shaft.
Check freedom of movement of armature.

Torque wrench:	comm. avail.
Torquemeter:	0 986 617 166
Tightening torque:	35...45 Nm

Continue: VI21/1 Fig.: VII16/2

KMS00663



CHECKING RETURN FORCE OF COIL SPRING ON ENGAGEMENT ROD

Return force is checked with starter fitted.
In rest position it must be possible to press back pinion, with spring action being provided by rubber buffer in thrust piece of starting-motor solenoid.
In rest position, engagement rod must rest on ball in starting-motor solenoid.

Initial force:	80...100 N
Ultimate force:	125...145 N

Continue: VI21/1

ASSEMBLING REDUCTION GEAR (TYPE TF 0 001 608 .../... 611)

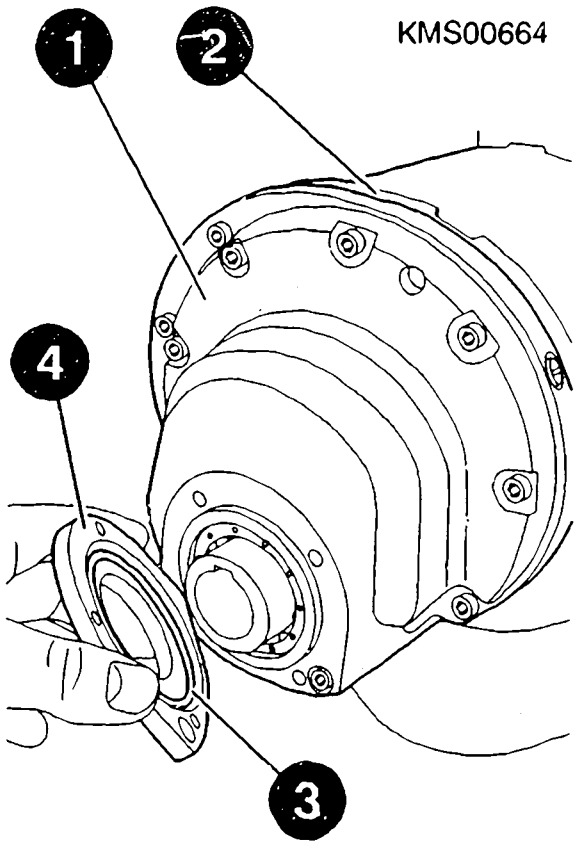
Also Type TF 32 V/36 V - 0 001 6.. ...

Position reduction gear end shield (1) on drive end shield (2) and secure. Watch out for straight pins in drive end shield. Use torque wrench..

ATTENTION: Make sure labelling of cylindrical roller bearing in reduction gear end shield is not visible.

Torque wrench:	comm. avail.
Tightening torque:	9...11 Nm

Continue: VII19/1 Fig.: VII18/2



ASSEMBLING REDUCTION GEAR (TYPE TF 0 001 608 .../... 611)

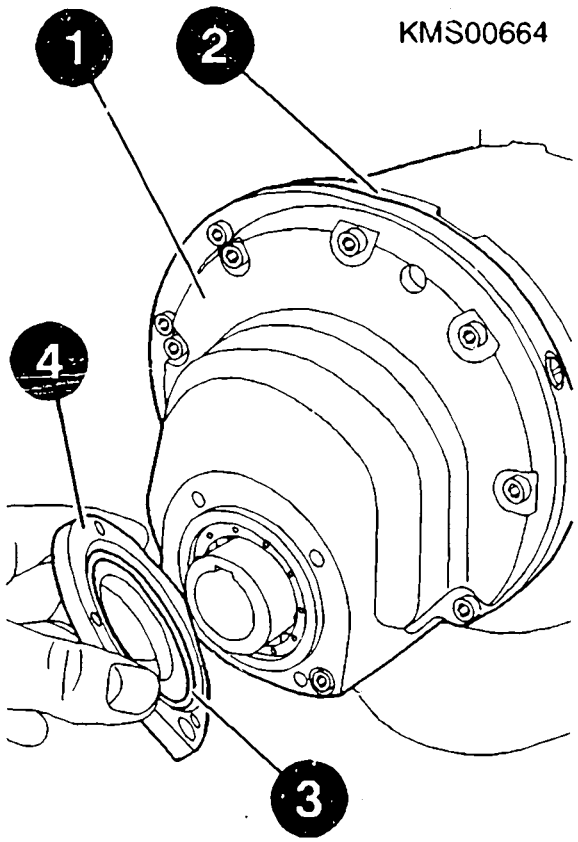
Also Type TF 32 V/36 V - 0 001 6.. ...

If applicable, insert new O-ring (3) in cover (4) and fit cover.

Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	9...11 Nm

Continue: VII20/1 Fig.: VII19/2



ASSEMBLING REDUCTION GEAR
(TYPE TF 0 001 608 .../... 611)

Also Type TF 32 V/36 V - 0 001 6.. ...

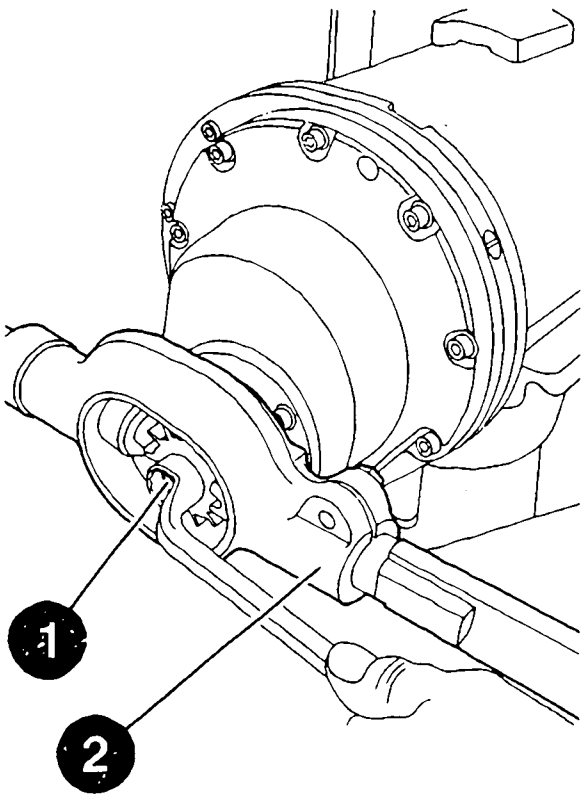
Insert pinion in reduction gear shaft and secure with new micro-encapsulated bolt (1).
Use torquemeter (2) for support.

Check freedom of movement of armature.

Torque wrench:	comm. avail.
Torquemeter:	0 986 617 166
Tightening torque:	42...50 Nm

Continue: VI21/2 Fig.: VII20/2

KMS00586



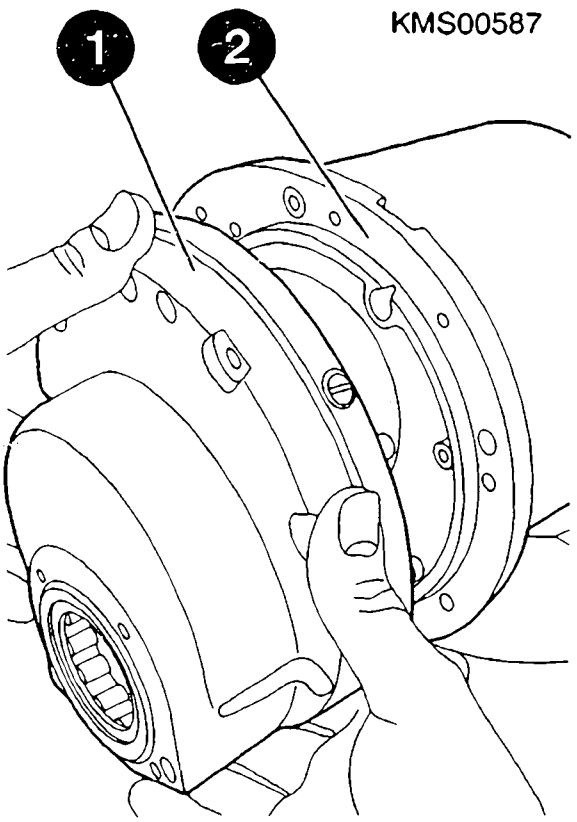
ASSEMBLING REDUCTION GEAR (TYPE TF 0 001 613 ...)

Position reduction gear end shield (1) on drive end shield (2) and secure. Watch out for straight pins in drive end shield.

Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	9...11 Nm

Continue: VII22/1 Fig.: VII21/2



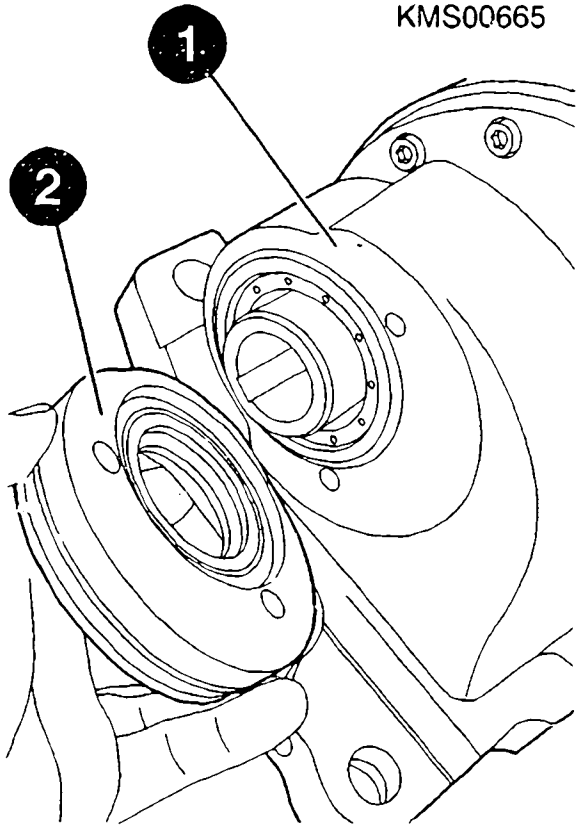
ASSEMBLING REDUCTION GEAR (TYPE TF 0 001 613 ...)

Apply thin coat of Hylomar sealant to contact surface of cover (2) and fit cover.

Use torque wrench.

Torque wrench:	comm. avail.
Hylomar sealant VS 9844 Kk:	5 927 350 002
Tightening torque:	20...25 Nm

Continue: VII23/1 Fig.: VII22/2



ASSEMBLING REDUCTION GEAR (TYPE TF 0 001 613 ...)

Insert pinion in reduction gear shaft and secure with new micro-encapsulated bolt (1).

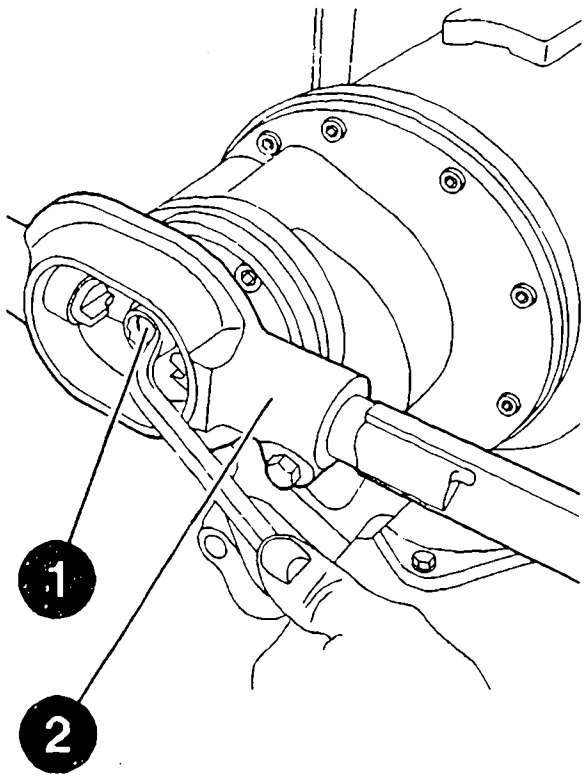
Use torquemeter (2) for support.

Check freedom of movement of armature.

Torque wrench:	comm. avail.
Torquemeter:	0 986 617 166
Tightening torque:	42...50 Nm

Continue: VI21/2 Fig.: VII23/2

KMS00589

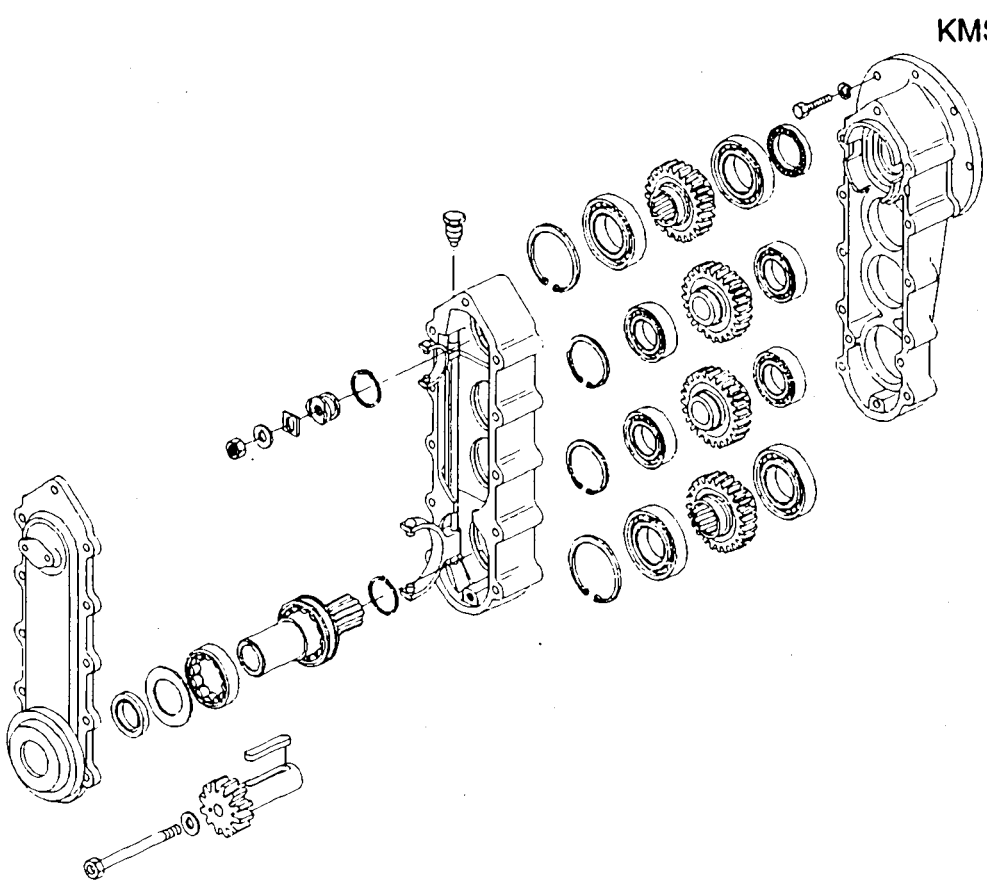


ASSEMBLING 4-SPEED REDUCTION GEAR (TYPE TF 0 001 6.. ...)

BLOCK DIAGRAM

Continue: VII25/1 Fig.: VII24/2

KMS00575



ASSEMBLING 4-SPEED REDUCTION GEAR (TYPE TF 0 G01 6.. ...)

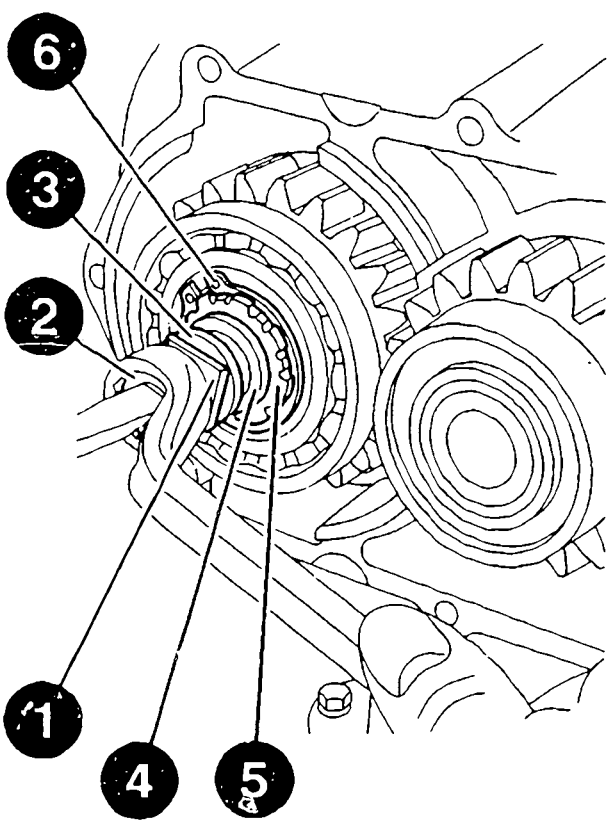
Insert reduction gear wheels together with deep-groove ball bearings/slip onto gear shaft (5).

Insert circlip (6) in groove of gear shaft (5).

Screw guide ring (4), square washer (3), tab washer (1) and nut (2) onto engagement rod.

Continue: VII26/1 Fig.: VII25/2

KMS00595



ASSEMBLING 4-SPEED REDUCTION GEAR (TYPE TF 0 001 6.. ...)

Mount housing (5), insert reduction gear shaft (2).

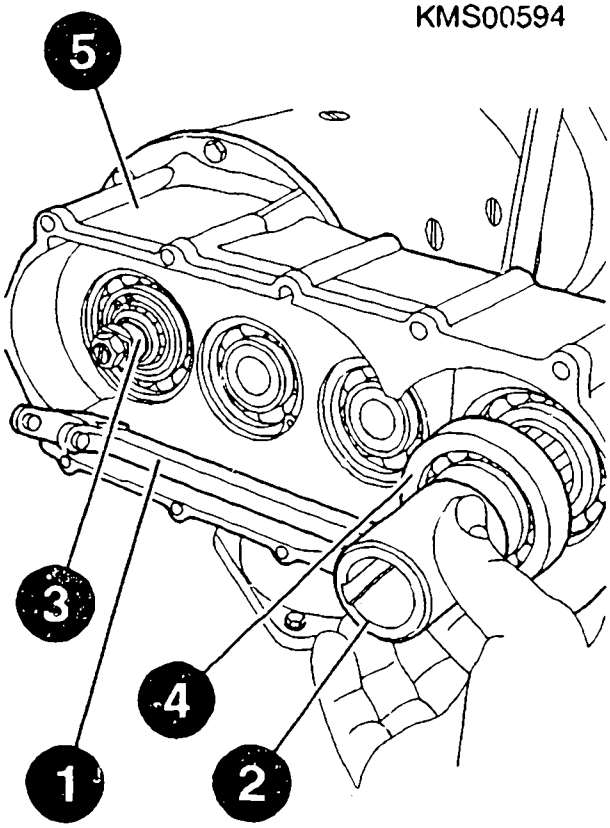
Engage control forks of fork lever (1) in guide ring (3) and switching ring (4).

* Axial play of fork lever: 0,1 mm
* Radial clearance of fork lever: 0,5 mm
  Adjust radial clearance by turning guide ring (3) on engagement rod

After setting, tighten nut of guide ring and bend over tab washer.

Continue: VII27/1 Fig.: VII26/2

KMS00594



ASSEMBLING 4-SPEED REDUCTION GEAR (TYPE TF 0 001 6.. ...)

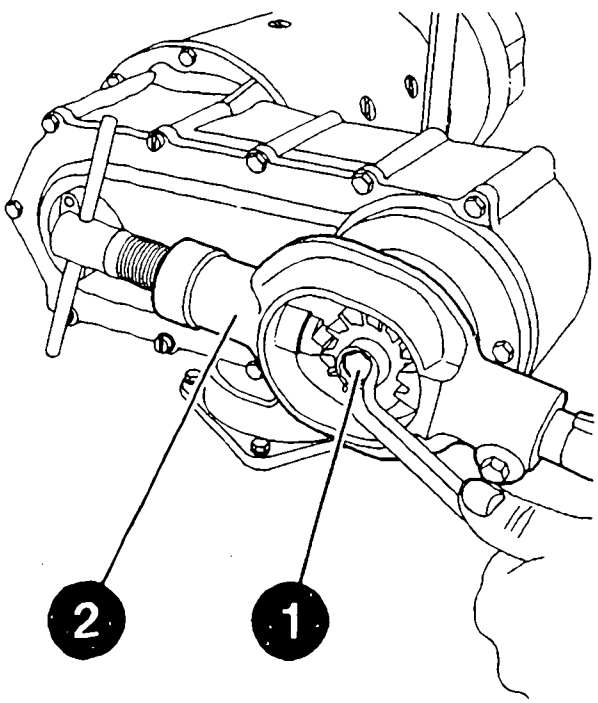
Fit cover.
Insert pinion in reduction gear shaft and secure with new micro-encapsulated bolt (1).
Use torque wrench.
Provide support with torquemeter (2).

Check freedom of movement of reduction gear.

Torque wrench:	comm. avail.
Torquemeter:	0 986 617 166
Tightening torque:	42...50 Nm

Continue: VI21/2 Fig.: VII27/2

KMS00593



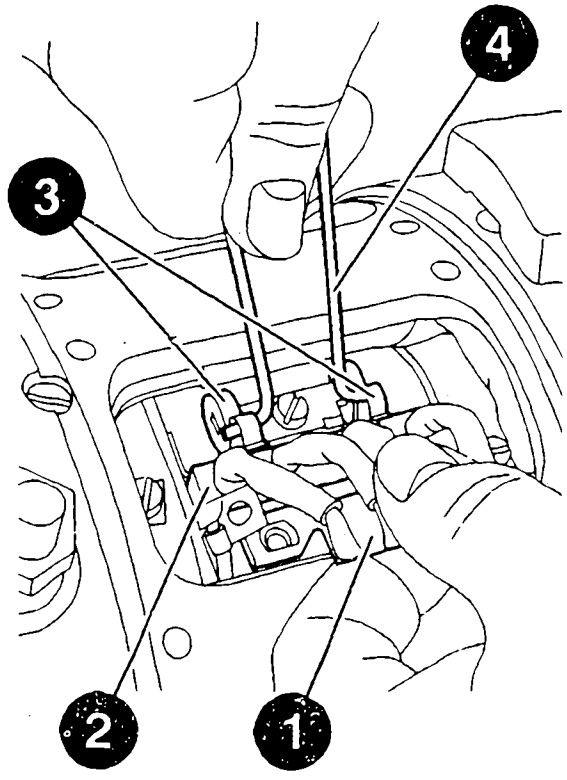
ASSEMBLING CARBON BRUSHES

Use tool (4) to lift springs (3) and insert carbon brushes (2).
NOTE: Pay attention to fitting location on installing carbon brushes already used. Lay connections of carbon brushes (1) such that brushes can move slightly in cartridge-type holders.

Secure connecting leads to positive and negative cartridge-type brush holders.

Continue: VIII01/1 Fig.: VII28/2

KMS00602



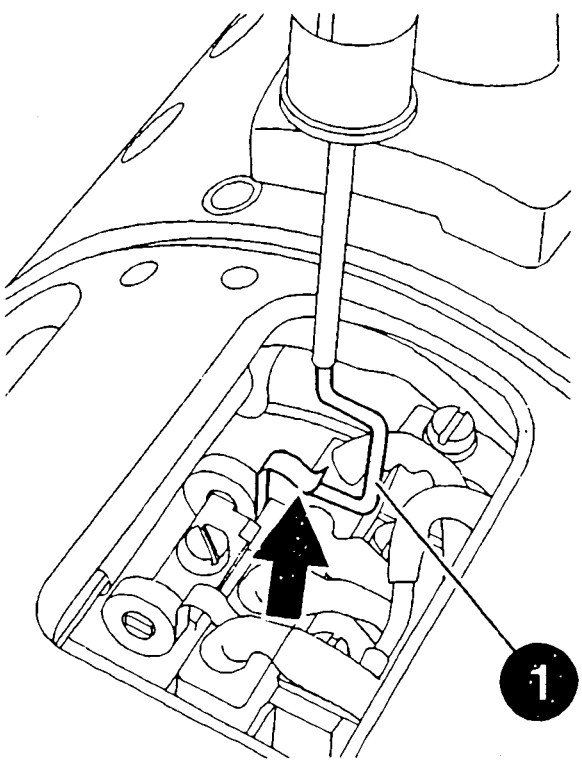
ASSEMBLING CARBON BRUSHES

Check brush contact force with spring balance.
To do so, apply spring balance (1) at contact point (arrow) of each spring on carbon brush and pull perpendicular to spring.

Spring balance:	comm. avail.
Brush contact force per compression spring:	9,0...13,5 N

Continue: VI21/2 Fig.: VIII01/2

KMS00665



ASSEMBLING CAP

If applicable, attach new O-ring to stator housing.

Fit cap (1).
Make sure O-ring is correctly positioned.

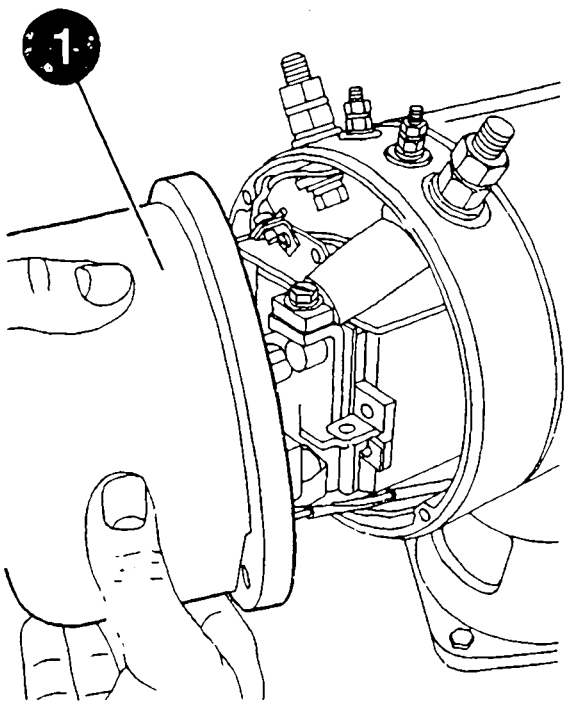
NOTE: Cap can only be mounted in one position.

Secure cap.
Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	5,3...6,6 Nm

Continue: VI21/2 Fig.: VIII02/2

KMS00596



ASSEMBLING CAP
(TYPE TF 0 001 613 ...)

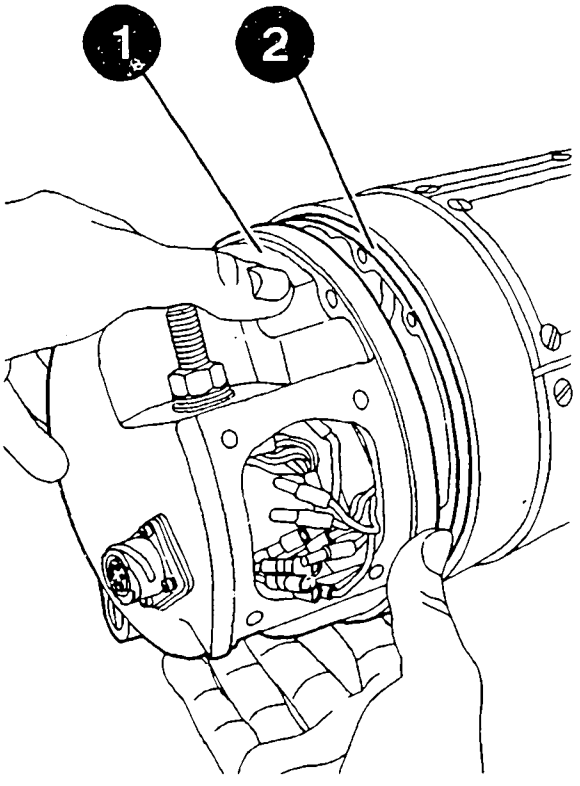
If applicable, attach new O-ring (2) to stator housing.

Type TF 0 001 613 003 only:
Completely assemble connection term. 31.

ATTENTION: Note sequence of individual washers and insulating parts.
Watch out for insulating sleeve in hole in commutator end shield.

Continue: VIII04/1 Fig.: VIII03/2

KMS00600



ASSEMBLING CAP
(TYPE TF 0 001 613 ...)

Fit cap (1).

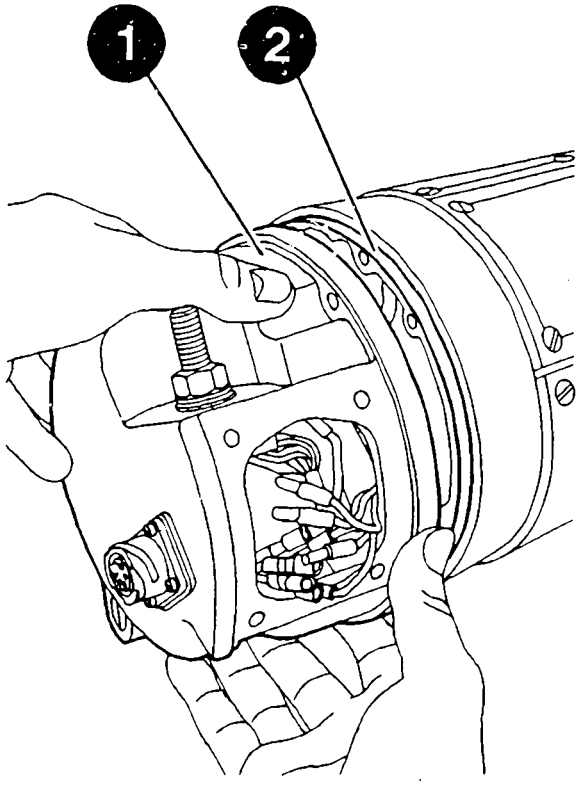
Make sure O-ring is correctly fitted.

Secure cover.

ATTENTION: Usit rings are always to be re-inserted beneath bolts.

Continue: VIII05/1 Fig.: VIII04/2

KMS00600



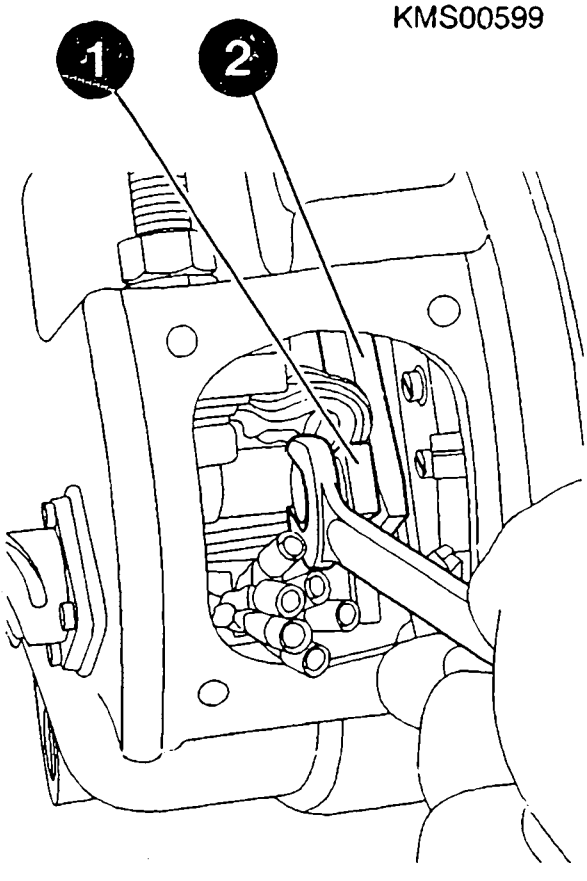
ASSEMBLING CAP
(TYPE TF 0 001 613 ...)

Attach ribbon cable (1) of contact rail (2) of starting-motor solenoid to term. 30.

NOTE: On Type TF 0 001 613 001, connection term. 30 is designed as a high-current socket.

Continue: VIII06/1 Fig.: VIII05/2

KMS00599

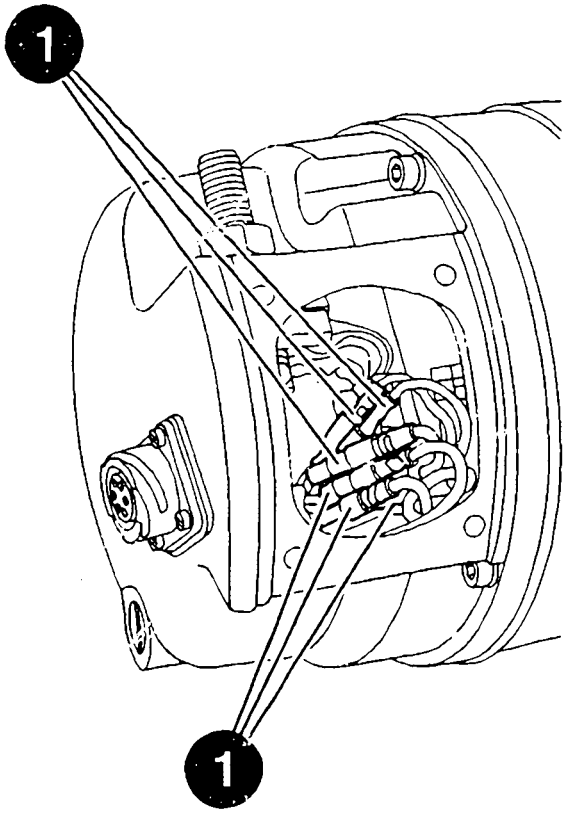


ASSEMBLING CAP
(TYPE TF 0 001 613 ...)

Attach cable connections (1) (plugs and jacks) of terminals 50, 50z, 48, 30 and term. 30F to socket.
Pay attention to identical cable colors.
Use cable tie to attach all the cables to one another.
Take care to avoid contact with moving parts.

Continue: VIII07/1 Fig.: VIII06/2

KMS00598



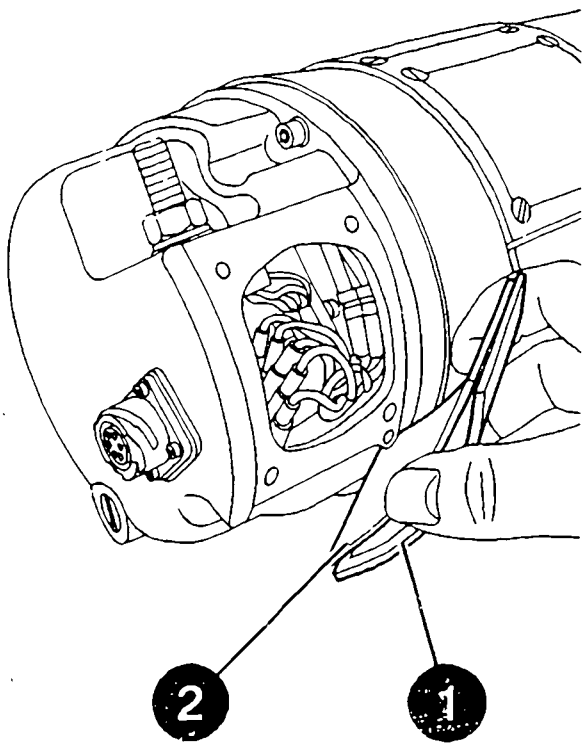
ASSEMBLING CAP
(TYPE TF 0 001 613 ...)

Apply Hylomar sealant to edge of sealing plate (2) and fit plate. Use new sealing plate if necessary. Secure cover plate (1).

Hylomar sealant
VS 9844 Kk: 5 927 350 002

Continue: VI21/2 Fig.: VIII07/2

KMS00597



ASSEMBLING COVER PLATES

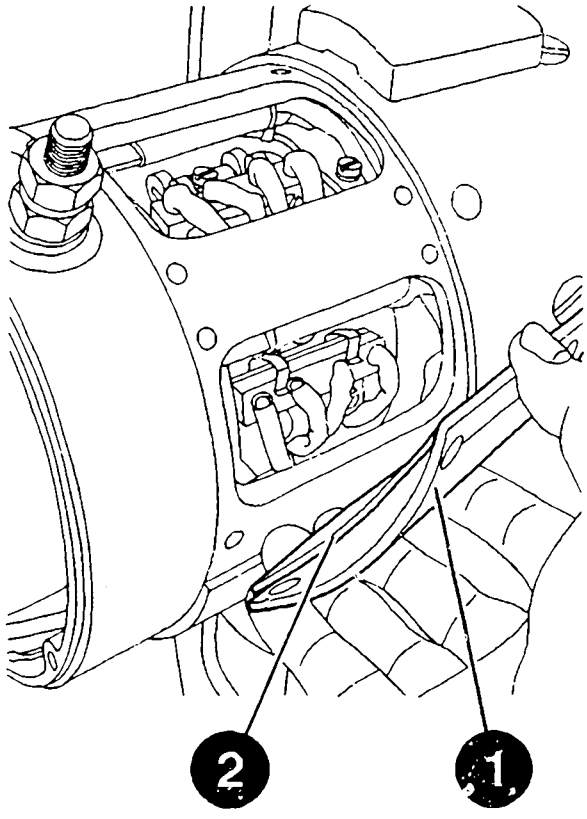
Apply sealing putty to edge of clamping strap and fit strap.

Apply Hylomar sealant to edges of sealing plates (2) and fit plates.
NOTE: Use new sealing plates if necessary.
Secure cover plates (1). Seal bolts with locking compound.

Locking compound:	comm. avail.
Sealing putty Kk 1 v 3:	5 703 452 150
Hylomar sealant VS 9844 Kk:	5 927 350 002

Continue: VI21/2 Fig.: VIII08/2

KMS00601



CHECKING INSULATION

Use high-voltage insulation tester to perform insulation check.

ATTENTION: DANGER OF FATAL INJURY
Always pay attention to OPERATING INSTRUCTIONS and SAFETY PRECAUTIONS of equipment manufacturer.

Continue: VIII09/2

CHECKING INSULATION

Measurement points:
Measure all terminals brought out to housing.

Test conditions:

- Test temperature:	+20...+30 C
- Test voltage:	100...110 V
- Insulation resistance:	> 0,05 MOhm

High-voltage insulation tester:	comm. avail.

Continue: VI22/1

LEAK TEST

In the case of starting motors with protection against oil and water, leak test is to be performed following assembly.

The procedure involved is described on a separate microfiche.

Further details can be found in the microfiche directory W-001/000

Continue: VI22/1

CHECKING BACKLASH

Check play between tooth flanks of starter pinion and ring gear/gear segment.

To do so, mesh starter pinion by hand.

Backlash:	0,7...0,9 mm
Feeler gauge:	comm. avail.

Continue: VI22/1

ADJUSTING PINION - RING GEAR GAP

The gap between the starter pinion and ring gear is to be set in line with the quotation drawing applying to the type of starter concerned.

Pinion - ring gear gap:	1,5...4,5 mm

Continue: VI22/1

EDITORIAL NOTE

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Continue: VIII12/2

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Continue: I01/1